W472-TAO-001-90

UNCLASSIFIED

FINAL REPORT

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN (U)

MAY 1990

Advanced Studies

VOLUME 1
EXECUTIVE SUMMARY, METHODOLOGY AND USER'S GUIDE

19980302 081

CONTRACT NO: 86-N194100-000

TECHNOLOGY ASSESSMENT OFFICE

TRW
DEFENSE SYSTEMS GROUP
SPECIAL PROGRAMS
ONE SPACE PARK, REDONDO BEACH, CALIFORNIA 90278

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

BMDOTIC

U2899

LASSIFIED

DTIC QUALITY INSPECTED 4

BMDOTIC

Report Number: W472-TAO-001-90
Accession Number: 2899
Title: Survey of Advanced Technologies in
Japan, Vol. 1: Executive Summary,
Methodology and User's Guide
Personal Author: Kanarek, S.; Smitha, P.; Mecherle,
S.; Cantafio, L.; et al.
Contract Number: 86-N194100-000
Corporate Author or Publisher: TRW, Special Programs, Technology
Assessment Office, Redondo Beach, CA
Publication Date: May 01, 1990
Pages: 00086
Descriptors, Keywords: Technology Assessment Japan
Aerospace Communication Laser Sensor
IR FPA X-ray Lithography Diamond
Status

W472-TAO-001-90

UNCLASSIFIED

COPY NO: 001
TOTAL PAGES: 89

FINAL REPORT

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN (U)

MAY 1990

VOLUME 1
EXECUTIVE SUMMARY, METHODOLOGY AND USER'S GUIDE

CONTRACT NO: 86-N194100-000

TECHNOLOGY ASSESSMENT OFFICE

TRW
DEFENSE SYSTEMS GROUP
SPECIAL PROGRAMS
ONE SPACE PARK . REDONDO BEACH . CALIFORNIA 90278

UNCLASSIFIED

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

TABLE OF CONTENTS

PREFACE		1
1.0	INTRODUCTION	3
1.1	PURPOSE	3
1.2	SCOPE	3
1.3	APPROACH	4
2.0	DATABASE ENTRY FORMAT AND FIELDS	6
3.0	TRW TECHNOLOGY CONSULTANTS	15
4.0	CTAS DATABASE REPORTS	17
4.1	SUMMARY REPORT	17
4.2	PARAMETER NAME REPORT	17
4.3	DATABASE ENTRY REPORT (PRIMARY)	17
4.4	DATABASE ENTRIES FOR SECONDARY REPORTS	21
4.5	DATABASE ENTRY NOTES (MEMO FIELDS) REPORT	21
5.0	LIST OF PRINCIPAL ORGANIZATIONS IN EACH TECHNOLOGY	24
6.0	DATABASE USER'S GUIDE	31
6.1	INSTALLATION	31
6.2	OPERATIONS	31
6.3	HELP	36

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

TABLE OF CONTENTS (Continued)

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS 37

APPENDIX 2 - MILITARILY CRITICAL TECHNOLOGIES LIST (PARTIAL) 55

APPENDIX 3 - CROSS-REFERENCE LIST OF FIELD NAMES 58

APPENDIX 4 - LIST OF DATA SOURCE CODES
A: (CODE ORDER) 61
B: (ALPHABETICAL ORDER) 69

APPENDIX 5 - LIST OF CRITICAL TECHNOLOGIES AND SUB-TECHNOLOGIES 77

APPENDIX 6 - LIST OF KEYWORDS USED FOR DATA SEARCHES 81

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

PREFACE

This document is the first of five volumes that comprise TRW's final report on the Survey of Advanced Technologies in Japan. This study, which investigates the status of ten key aerospace technologies in Japan, was conducted by the Technology Assessment Office of TRW's Special Programs and was supported by a team of technology specialists selected from TRW's Space & Defense Sector.

The study was sponsored by the Office of Information Resources (OIR), the Office of East Asian Analysis (OEA), and the Space Defense Initiative Office (SDIO). Ms. Carda Traunero (OIR) and Ms. Marybeth A. Davis (OEA) were the principal contract monitors.

This is the fourth in a series of foreign technology studies conducted by TRW/TAO during the past four years, and it represents a culmination of TRW's attempts to streamline the process with the maximum use of computers (PCs) and a highly effective team of management, advanced-technology specialists, and the ideal mix of junior and senior technology analysts. Our goal has been to provide the customer with a study that contains the greatest amount of useful analysis, and specific technical content, in a valuable, flexible database, all in the most cost-effective manner. Accordingly, we have, chosen to concentrate our efforts in data collection and analysis and minimize efforts that would contribute to the appearance rather than the technical quality of this final report. Thus, some sections of this final report which were originally presented as status briefings, have been incorporated herein without being reformatted.

The second volume, Technology Tutorials, Baselines, and Japan's Top Performers, is a classified document (COL-004-S20060-90) which provides a full set of tutorials for each technology and copies of the screen display for their baseline data entries, as well as a report that identifies only those organizations and activities to which TAO assigned an achievement rank of "A", which represents a report of technology or performance that exceeds the values that describe the current U.S. baseline.

The third volume is the unclassified Database Reports, (W472-TAO-002-90) which contains a printout of the unclassified database for each of the ten technologies investigated. Each technology package contains a Summary Report, a List of Parameter Names and Units, a Primary Entry Report, a Secondary Entry Report, and a Memo Field Report. Together, these five report formats contain virtually all of the material contained in the database.

The fourth volume of this report is the classified Database Reports,(COL-004-S20061-90) which consists of the same series of five report formats that are used for the unclassified database.

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

The fifth volume of this report is the Database Diskette Masters, (COL-004-S20062-90) which contains one program diskette and ten data diskettes, one for each technology. Each of these data diskettes hold the complete integrated database for a technology, including both the unclassified and the classified materials.

This study was structured and managed by Mr. Shepard Kanarek, manager of TRW's Technology Assessment Office (TAO), who has conducted a broad range of technical studies for the intelligence community since 1975. Mr. Kanarek has nearly thirty-five years of experience in the research, development and production of sophisticated aerospace systems and components. Early in his career, he designed electro-mechanical and electro-optical systems and components for military and space applications, including radar, guidance and control, command and control display systems, and instrument lasers. Before joining TRW he was Chief Industrial Engineer of two small aerospace developers, Belock Instruments and Kollsman's Space Division. After joining TRW in 1968 Mr. Kanarek conducted industrial engineering and technology studies related to the development and production of the Minuteman Weapon System and served as Assistant Program Manager of the Viking Biology Instrument, and was responsible for its integration and assembly. For the past 15 years, he has managed and been the principal analyst in a continuing series of studies for SOVA and EURA, including cost analyses of Soviet missiles, SLV's and spacecraft, assessments of Soviet production capabilities, and a significant number of comparative evaluations of foreign aerospace technologies.

Mr. Kanarek was assisted in this study by a staff of senior TRW scientists and engineers, who are highly respected specialists in the technologies investigated:

Technology	TRW Consultant
Voice & Data Communications Encryption	Paul Smitha
Space-Based Laser Communications	Steve Mecherle, Ph.D.*
SAR for Space-Based Remote Sensing	Leopold Cantafio *
Attitude Control for Heavy Spacecraft	Victor Spector, Ph.D.*
IR Detectors & Focal Plane Arrays	Gary Grimm, Ph.D.*
X-Ray Lithography	Richard Tauber, Ph.D.
E-Beam Lithography	Richard Tauber, Ph.D.
Diamond Coatings & Films	John R. Ogren, Ph.D.*
High-Speed Data Processing	Shi-Ping Hsu, Ph.D.*
High-Resolution Flat Panel Displays	Harry Campbell

Mr. Kanarek also utilized many other resources within the world-wide structure of TRW to collect and analyze the data assembled in this survey.

* Resume in Appendix 1 of this volume

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

1.0 INTRODUCTION

1.1 PURPOSE

This report presents the results of a survey of the status of ten advanced aerospace technologies in Japan, relative to the United States as a baseline. The study was conducted by the Technology Assessment Office (TAO) of TRW Special Programs during the period of May 1989 through May 1990. The technologies investigated, which were specified by the sponsor, are the following:

A. Voice & Data Communications Encryption
B. Space-Based Laser Communications
C. Synthetic Aperture Radar for Space-Based Remote Sensing
D. Attitude Control for Heavy Spacecraft
E. IR Detectors & Focal Plane Arrays
F. X-Ray Lithography
G. E-Beam Lithography
H. Diamond Coatings & Films
I. High-Speed Data Processing
J. High-Resolution Flat Panel Displays

1.2 SCOPE

The intent of this survey has been to gather and analyze all-source data on each of these technologies to identify the status in Japan by answering the following questions:

1. Which are the leading companies or organizations, names and addresses ?

2. Who are the key researchers or program managers ?

3. What is the current status of the technology; R&D, laboratory demonstration, pilot production, or full scale production ?

4. What are the specific technical accomplishments ?

TAO proposed to develop and utilize a computerized database for this survey that would guarantee full traceability of the source data and that would capture the data in a manner that would permit the customer to sort and search it from virtually every aspect.

TAO elected to construct a specially designed relational database within the framework of dBase III+, and which is fully compatible with the dBase III standard utilized by the customer.

1.3 APPROACH

TAO named this specially designed relational database the "Critical Technology Assessment System" (CTAS). This is a unique database structure that integrates a "question" database with an "answer" database and thus permits us to use one common structure to record technical performance data for any number of different technologies even though the parameters and units that are used to measure that performance are different for each of the technologies.

Thus, the question database permits us to enter up to six parameters for a specific technology and to also identify the units of measure for each of those parameters as well as the direction of improvement (whether that parameter must increase or decrease for an improvement in performance). The data for that technology is entered into the answer database under the six parameter slots that correspond to those questions.

The databases are tied together in this relation via the CTL number which is a 10 character code that we have developed to identify every possible critical technology that we are studying, or may study in the future. This CTL (critical technology list) number has been devised to roughly coincide with the structure of the Militarily Critical Technologies List (MCTL) developed and maintained by DOD/OUSDRE. Appendix 2 of this report presents a partial listing and breakdown of the MCTL, to illustrate where and how the ten technologies covered by this survey fit into that very broad technology classification system. Each of the ten technologies surveyed are marked with a string of asterisks.

When a new CTL number is input to CTAS, the system requires that we input the parameter names, units of measure and direction of improvement for each of up to six parameters. It then asks us to enter the data for the first entry under that CTL number. The next time that CTL number is entered, CTAS locates the list of parameters, the units of measure and the improvement direction, in the question database and displays them for us to use when making a new data entry under that CTL number. Thus, the database will store any quantity of data entries under that same CTL against the one set of questions, originally entered. If we choose to sort the data, by using the CTL to limit the entries that are sorted or searched, we will always be sorting and comparing data that responds to the same set of questions.

This unique database structure is totally flexible, permitting us to utilize it to store and compare data on any kind of technology, regardless of whether it is a high level system that performs a complete operational function, or a subsystem, or even a low-level component, material or process that is just a minor

part of a high-level system. This flexibility is demonstrated in Figure 1-1 which illustrates the various levels and sub levels of a functional system.

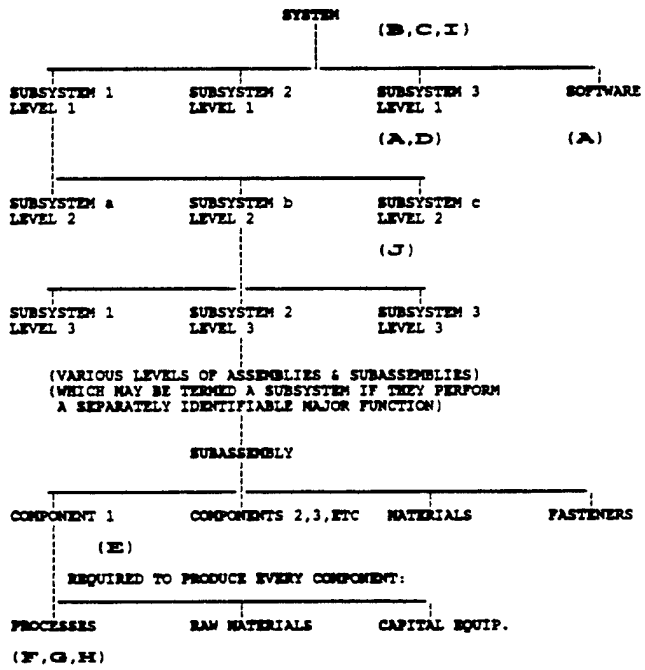


FIGURE 1-1 GENERIC SYSTEM TREE WITH STUDY TECHNOLOGIES

This tree-like figure illustrates that a system is comprised of subsystems and that each subsystem (at level 1) may contain a group of subsystems (at level 2) and so-on to level 3 or further. It also discloses that a subassembly is ultimately composed of components, materials and fasteners, and that a component may require processes, materials and capital equipment for its manufacture.

Our database structure can accommodate a technology at any level of this system tree, and the letters A thru J that appear in the figure correspond to the technologies covered in this study (see section 1.1). Technologies labelled B, C and I are systems while F, G and H are processes.

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

2.0 DATABASE ENTRY FORMAT AND FIELDS

Figure 2-1 is a reproduction of the screen display during a data entry. Below it is a detailed explanation of each field and its utility to the overall database. The example shown in the figure is a baseline entry, in which TAO has entered state-of-the-art values for the U.S. and in which the memo field contains a tutorial explaining the general concepts of the technology.

```
                                                          CTL: 0601010400
 B. SPACE BASED LASER COMMUNICATIONS          Answers     Sheet #: A
                                                        Tech Code: SBLC
CAT: COMP          SUB TECH: HIGH-POWER SEMICONDUCTOR DIODE LASER

P:B L:  REF:         CTRY:BL SOURCE:JAB/SUMMER-88/023    INFO:07/05/89 PAGE:B0000

DESCR:T memo  STATUS:X  PHASE:NA  WHEN:  /  /    SECURITY:U  ANALY:SSK

   NAME:                 ORGANIZATION:        LOCATION:        COMMENTS:
A  N/A
B  N/A
C  N/A

I  PARAMETER:                  VALUE:      UNITS:            B: NOTES:
1  WAVELENGTH                  0.78        u (MICRONS)       X  FOR GALLIUM ARSENI
2  LASER POWER                 0500        mW (MILLIWATT)    H
3  POWER CONVERSION EFFICIEN   050         % (PERCENT)       H
4  ARRAY SIZE (PHASE LOCKED)   008         ELEMENTS          H  MINIMUM
5  BEAMWIDTH - TRANSVERSE      040         DEGREES           L
6  BEAMWIDTH - LATERAL         010         DEGREES           L

EDIT            |<B:>|ANSW                 |Rec: 2/39          |      |  Caps
```

MEMO FIELD (TUTORIAL FOR BASELINE ENTRY)

```
HIGH POWER SEMICONDUCTOR LASER DIODE

The laser diode (which is sometimes called a diode laser) is the
primary candidate of the four principle sources of laser energy
for space communications applications.  The laser diode is small,
relatively efficient, rugged, available over the wavelength range
of 0.8 to 1.7 microns, has long life potential, and can be
directly modulated for the transmission of data.  The main
```

FIGURE 2-1 EXAMPLE OF A DATA ENTRY RECORD (Baseline Entry)

DEFINITIONS:

Key Technology - One of the ten technologies being studied.

Sub-Technology - A technology supporting or used in one of the key technologies

Field Sizes are shown in parenthesis.

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

DATABASE FIELD NAMES VERSUS SCREEN DISPLAY FIELD NAMES

The field names that appear on the screen, in Figure 2-1, and are used to explain the field contents in the section below, are not necessarily the same names used within the dBase III+ file structure.

IMPORTANT NOTE: When you create a new "Query" or a new" Report" form, or even if you just "Build a Search Condition" or "Construct a Field List" during use of the database, you will have to select the fields from a list on the screen that uses their official database field names rather than the ones used in Figure 2-1. Appendix 3 of this report is a cross-reference list that will help you identify the official field name.

DATA BASE ENTRIES

Each record consists of three major areas (A, B & C). The first section (A) describes the key technology or sub technology and the source data. The second section (B) reports who the researchers or principals of that technology are and the third section (C) identifies their status through the identification of levels achieved for the specified parameters.

****
A. Technology Identification Section
****

CTL (10): This is a code number used by dBase III+ to file this record with identical technologies and will be important in future data searches. The code is structured to identify the major and sub categories within which the technology is organized. It closely parallels the coding used in the Militarily Critical Technology List (Appendix 2). See the CTL list developed for this study in Appendix 5.

SHEET # (1): If a key technology, or a sub technology has more than 6 critical parameters and requires two or more screens this code would be a B or a C to identify the second or third screens, otherwise it will always be an A. When combined with the CTL code and the PAGE entry it provides a unique number that identifies only this (physical) record within the data base.

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

TECH CODE (8): This entry is just the first letters of the full name of the key technology.

Key Technology	Code
Voice & Data Communications Encryption	VDCE
Space Based Laser Communications	SPLC
Synthetic Aperture Radar for Space_Based Remote Sensing	SARSBRS
Attitude Control Systems for Heavy Spacecraft	ACSHS
IR Detectors & Focal Plane Arrays	IRDFPA
X-Ray Lithography	XRL
E-Beam Lithography	EBL
Diamond Coatings & Films	DCF
High Speed Data Processing	HSDP
High Resolution Flat Panel Displays	HRFPD

REC: This is the record number that dBase III Plus uses to store and retrieve this record (screen) of data within the file for this key technology. During editing it may show 37/408 indicating that it is record 37 of a total of 408. This number appears in the footer of each record rather than the body.

CAT (10): This entry describes the category of technology reported in the record using the following abbreviations:

Category	Abbreviation
System Performance	SYS PERF
Design Technology	DES TECH
Component	COMP
Material	MAT
Process	PROC
Facility	FAC

SUB TECH (80): This entry is a brief name or description of the supporting technology being reported in this record. It corresponds to the CTL number and in some cases the SHEET #.

Example: Chemical Vapor Deposition

P (1): This single digit entry (either a P, an S or a B) is used to classify each record as to whether it is the "primary" record of that technology achievement, or if it is a "secondary" record, providing additional details in connection with a "primary" record. A "B" in that field identifies records that are neither primary or secondary records, but are "baseline" records that provide a tutorial and establish the state-of-the-art levels for the parameter values.

L (1): This single digit entry identifies TAO's evaluation of the level of achievement described in this record (compared to the U.S.baseline). The identification of this ranking is as follows:

A	Better
B	Good
C	Moderate
D	Poor
E	Insufficient Data

REF (5): This 5 character field is used on a "secondary" record to cross-reference it to the "primary" record it is associated with. It is used on a "primary" record in the unclassified database to cross-reference it to a related primary record in the classified database. It is also used on "primary" records in the classified database to cross-reference them to the associated record in the unclassified database.

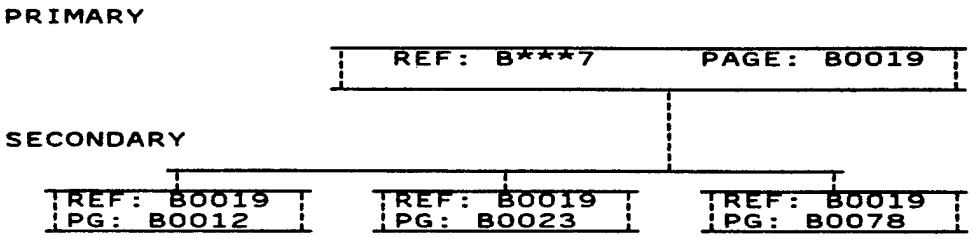
In every case the 5 digit code that appears in the reference field is the same code that appears in the "PAGE" field of the record being cross-referenced. "Page" fields in the unclassified database contain zeros (e.g. B0019) while "Page" fields in the classified database use asterisks (*) in place of the zeros (e.g. B***3).

Figure 2-2 illustrates these relationships.

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

REFERENCE FIELD IDENTIFIES RELATED ENTRIES

UNCLASSIFIED DATABASE:



CLASSIFIED DATABASE:

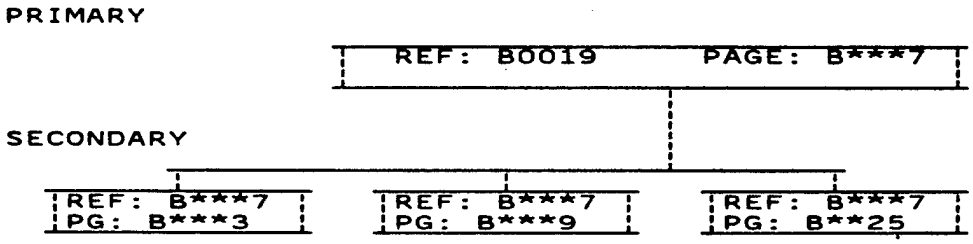


FIGURE 2-2 REFERENCE FIELD RELATIONSHIPS

CTRY (2): The two-digit code identifying the country. These entries will represent either Japan (JA) or the United States, (baseline) (BL).

SOURCE (20): This field contains a code that identifies the source from which the data was collected. The first part of the code identifies the name of the data base, or publication; the second part identifies the issue, the volume, or the document number; and the third part identifies the page.

Example: JAA/03-14-89_/__241

The first character of the publication code (3) will always be a J for this study. JAA identifies the first source document on the source list.

The three sections of the source code are separated by slashes.

The second section (10), in this case identifies the March 14, 1989 edition of this publication

The third section (5), identifies the page number.

Appendix 4 contains a complete list of publication codes used for this study.

INFO (8): Contains the date of publication of the source report.

PAGE (4): The entry in this field (when used in combination with the CTL code described above) identifies this screen uniquely with respect to this technology category. It also identifies that this screen is the first (or nth) report on this key technology. Where a record has multiple sheets the page number should be repeated for each of the multiple sheets.

DESCR (1): This field will contain either a Y or a N to indicate whether the record has a "memo" field associated with it.

MEMO (4000): The memo field may be used for a number of purposes. If the record is the first one covering that sub technology, the memo field contains a tutorial that describes the technology, explains some of its functions and features, and describes the most common applications. If the record covers the report of a sub-technology and the important events cannot be conveyed by the parameter and value fields (described below) then the memo field may contain a selected portion of the source document, that has been captured with an optical character reader. In those cases, it is often difficult to avoid typographical errors created by the OCR.

The memo field is accessed by using CTRL-PGDN with the cursor on the word "MEMO". You may return to the full entry screen by using CTRL-PGUP.

STATUS (1): Identifies whether this record indicates that the performance indicated in the report was "achieved" on the date stated or is merely "planned" for that date. "A" = Achieved while "P" signifies Planned.

PHASE (2): This entry describes which phase in the development of the key technology is supported by the event(s) related in this report, using the codes below:

Development Phase	Code
Research & Development	RD
Demonstration of Technology (Lab Demo)	DT
Technology Transfer (Design for Production)	TT
Producibility Engineering (Manufacturing Engrg)	PE
Pilot Production (Test Run of Production Line)	PP
Full Production (Quantity Manufacturing)	FP

WHEN (8): This is the reported date of the actual achievement or the planned date of achievement.

SECURITY (1): The letter in this field signifies the security classification of the data contained in this data base entry. U=Unclassified, C=Confidential, S=Secret.

ANALY (11): This field contains a code to identify the analyst(s) who reviewed the data and made this entry.

****
B. Principal Researchers Identification Section
****

This section provides for the entry of data on up to three principal researchers who are responsible for the technology development being reported in this record. There are fields for the researcher's name, his organization and its location, as well as comments. When there are more than one researcher at each organization, their names will be listed, together in the NAME field or may be continued in the COMMENTS field.

NAME (40): Title, First and Last Name of principal researchers.

ORGANIZATION (120): Name of company or research institute, or university, and names of division, department and section (as available)

LOCATION (120): Address, Province, City, and State, etc.

COMMENTS (100): Their role or assignment and other notes.

****
C. Technology Performance Data Section
****

This section provides for the entry of data on the six most important parameters of the technology. When a technology must be described by additional parameters, a second and third record has been created to cover them. It would be identified with a B or C in the SHEET field, described above. The contents of these data fields are as follows:

PARAMETER (80): The name or description of the parameter.

VALUE (30): The value of this parameter that has been achieved or is being planned to be achieved, according to this report.

UNITS (30): The units in which the parameter value is expressed.

B (1): The single letter that appears in this field signifies in which direction the parameter must move for "better" performance; that is whether a higher (H), or lower (L) value of the parameter would provide better performance of the technology

NOTES (240): This field permits a substantial note about this parameter.

3.0 TRW TECHNOLOGY CONSULTANTS

TAO has carefully selected a team of senior technical specialists from our staff of scientists and engineers, to support this study. These experts, one for each of the technologies being investigated, were asked to provide the following:

Identify the major critical elements of that technology, including major subsystems, components, processes, facilities and materials.

For the basic technology and each of the major elements identified above, describe the six most important technical parameters, including the name of the parameter, the proper units of measure, the direction the parameter must move for an improvement in performance, and the current U.S. state-of-the-art values for each parameter.

For the basic technology and each of the major elements identified above, provide materials for a tutorial that explain what the technology is, its important features, and its key applications.

A list of keywords to use in a data search for information about the basic technology and each of the major elements.

Occasional support to the analysis of data collected.

Figure 3-1 is an organizational chart of TRW's Space & Defense Sector, showing the technology groups, located in the Los Angeles area, from which TAO drew its team of experts.

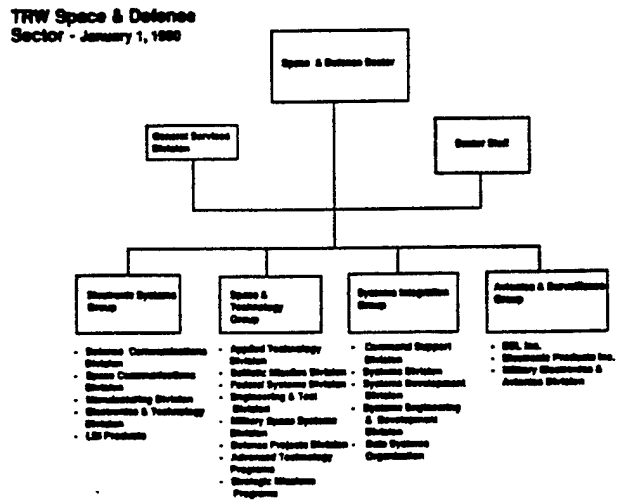


FIGURE 3-1 TRW' S SPACE & DEFENSE SECTOR

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

TRW maintains a number of corporate offices overseas to provide liaison with our many international operations and affiliations. The chart reproduced in Figure 3-2 identifies most of those international relationships. The corporate office in Tokyo and the far-eastern branch of our international office in Los Angeles was very helpful over the course of this study, providing us with materials not normally available through routine channels.

OVERSEAS CORPORATE OFFICES

BELGIUM - BRUSSELS
BRAZIL - SAO PAULO
CHINA - BEIHING
FRG - BARSINGHAUSEN
FRG - ESCHBORN
JAPAN - TOKYO
KOREA - SEOUL

COOPERATION AGREEMENTS

ENGLAND - BRITISH AEROSPACE *
FRANCE - MATRA *
THOMSON-CSF
GERMANY - DEUTSCHE AEROSPACE (DASA)
MBB-ERNO *
ITALY - AERITALIA *
JAPAN - HITACHI
IHI
SONY
NETHERLANDS - FOKKER *
SPAIN - INTA *
SWEDEN - SAAB *

OVERSEAS OPERATING UNITS

AUSTRALIA - 2
AUSTRIA - 2
BELGIUM - 1
BRAZIL - 3
CANADA - 20
CHINA - 1
ENGLAND - 8
FRANCE - 8
GERMANY - 16
ITALY - 3
JAPAN - 8
KOREA - 4
MALAYSIA - 1
MEXICO - 3
SPAIN - 3
SWITZERLAND - 1
TAIWAN - 2
THAILAND - 1
VENEZUELA - 1

TEAMING ARRANGEMENTS

ENGLAND - BRITISH AEROSPACE
GERMANY - DORNIER
SIEMENS
ISRAEL - ISRAEL AIRCRAFT INDUSTRIES
JAPAN - MITSUI

FIGURE 3-2 TRW'S INTERNATIONAL OPERATIONS & AFFILIATIONS

Appendix 5 of this report is complete list of the basic technologies and the major critical elements of each technology.

Appendix 6 contains the complete list of keywords that TAO used to search the all-source database for reports concerning these technologies.

4.0 CTAS DATABASE REPORTS

TAO has developed a set of five reports to provide the user with complete visibility of the database contents. The database for each technology has been indexed, first by the CTL number, then by the SHEET # and finally by the name of the ORGANIZATION identified on line A. Thus, the data in every report will be ordered in that manner. While each of the reports appears to be grouped by sub technologies, they correspond directly to the combination of a CTL and a SHEET #. The MEMO field report is further sub-grouped by the ORGANIZATION name.

4.1 Summary Report of Primary & Secondary Entries

This report is called SUMMARY in the dBase III+ report form structure. Figure 4-1 is an example of this report. Its purpose is to provide the user with a quick profile of the data, showing the achievement rank of each entry and identifying which entries are primary ones and which are secondary ones, under column P/S. The PAGE numbers are listed for each entry, as is the REF #, which ties secondary entries to the page number of the related primary entry. A "Y" in the MEMO column signals the presence of a memo field, and the ORGANIZATION column bears the name of the principal organization discussed in that entry.

4.2 Parameter Name Report

The CTAS database structure is designed to provide data slots for six key parameters for each technology or sub technology. Since each technology has a different set of key parameters and a different set of units for the parameter values, it is necessary to identify parameter 1 through parameter 6, <u>for each technology or sub-technology</u> stored in the database.

The Parameter Name Report, is called "QUEST" in the dBase III+ report form structure, because it actually provides three pieces of data for each of the 6 parameters, for each technology or sub-technology in the database, which then become the questions to be answered when an entry is made. It provides the name of the parameter, the units of measure for the parameter, and the direction of movement (H or L for higher or lower) that the parameter must go to register an improvement in the performance of the element. An example of this form is shown in Figure 4-2.

4.3 Database Entry Report

This report is used to present the data stored within each entry. In Volume 3 of this report, TAO has used the search condition to limit its contents to only "primary" entries. It is called "ANSW" in the dBase III+ report form structure. An example is shown in Figure 4-3. For every entry printed in the report it provides the following data:

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

Page No. 1
01/07/93

TECHNOLOGY ASSESSMENT OFFICE - TRW SPECIAL PROGRAMS
JAPANESE TECHNOLOGY STUDY
SUMMARY LISTING OF PRIMARY AND SECONDARY ENTRIES
TECHNOLOGY: SPACE BASED LASER COMMUNICATIONS

CTL #	SHET	CTRY	RANK	P/S	PAGE NO. HARD COPY	REF # PRIME ENTRY NO.	MEMO	ORGANIZATION 1
** *** SUB-TECHNOLOGY: Nd:YAG LASER								
06010 10100	A	BL		B	B0000		Y	BASELINE/TUTORIAL
** *** SUB-TECHNOLOGY: HIGH-POWER SEMICONDUCTOR DIODE LASER								
06010 10400	A	BL		B	B0000		Y	BASELINE/TUTORIAL
06010 10400	A	JA	C	P	B015B	P	Y	COMMUNICATION RESEARCH LABORATORY, MINISTRY OF POSTS AND TELECOMMUNICATIONS
06010 10400	A	JA	C	P	B013A	P	Y	MATSUSHITA ELECTRONICS CORP., ELECTRONICS RESEARCH LABORATORY
06010 10400	A	JA	C	P	B008A	P	Y	MITSUBISHI ELECTRIC CORP., CENTRAL RESEARCH LABORATORY
06010 10400	A	JA	B	P	B012B	P	Y	MITSUBISHI ELECTRIC CORP., CENTRAL RESEARCH LABORATORY
06010 10400	A	JA	C	S	B001A	B015B	Y	NATIONAL SPACE DEVELOPMENT AGENCY OF JAPAN, (NASDA)
06010 10400	A	JA	C	P	B002A	P	Y	NEC CORP.
06010 10400	A	JA	B	S	B016A	B015B	Y	NEC CORPORATION, SPACE & LASER COMMUNICATIONS DIVISION
06010 10400	A	JA	B	P	B003A	P	Y	OMRON TATEISI ELECTRONICS CO., CENTRAL R&D LAB.
06010 10400	A	JA	B	P	B005A	P	Y	SONY CORPORATION
06010 10400	A	JA	B	P	B005B	P	N	SONY CORPORATION

FIGURE 4-1 SUMMARY REPORT OF PRIMARY & SECONDARY ENTRIES

Page No. 1
01/07/93

TECHNOLOGY ASSESSMENT OFFICE - TRW SPECIAL PPOGRAMS
JAPANESE TECHNOLOGY STUDY
LIST OF PARAMETER NAMES, AND UNITS FOR EACH SUB-TECHNOLOGY
TECHNOLOGY: SPACE BASED LASER COMMUNICATIONS

CTL # SHEET TECH CODE	PARAMETER 1 NAME: --- UNITS: --- DIR. TO IMPROVE:	PARAMETER 2 NAME: --- UNITS: --- DIR. TO IMPROVE:	PARAMETER 3 NAME: --- UNITS: --- DIR. TO IMPROVE:	PARAMETER 4 NAME: --- UNITS: --- DIR. TO IMPROVE:	PARAMETER 5 NAME: --- UNITS: --- DIR. TO IMPROVE:	PARAMETER 6 NAME: --- UNITS: --- DIR. TO IMPROVE:	TECH CAT:
** ********** SUB-TECHNOLOGY: Nd:YAG LASER							
06010 10100 A SBLC	WAVELENGTH --- u (MICRONS) --- IMPR. DIR: X	LASER POWER --- mW (MILLIWATT) --- IMPR. DIR: H	POWER CONVERSION EFFICIENCY --- % (PERCENT) --- IMPR. DIR: H	BEAMWIDTH/DIFFRACT ION LIMIT --- NONE --- IMPR. DIR: L	--- --- IMPR. DIR:	--- --- IMPR. DIR:	COMP
** ********** SUB-TECHNOLOGY: HIGH-POWER SEMICONDUCTOR DIODE LASER							
06010 10400 A SBLC	WAVELENGTH --- u (MICRONS) --- IMPR. DIR: X	LASER POWER --- mW (MILLIWATT) --- IMPR. DIR: H	POWER CONVERSION EFFICIENCY --- % (PERCENT) --- IMPR. DIR: H	ARRAY SIZE (PHASE LOCKED) --- ELEMENTS --- IMPR. DIR: H	BEAMWIDTH - TRANSVERSE --- DEGREES --- IMPR. DIR: L	BEAMWIDTH - LATERAL --- DEGREES --- IMPR. DIR: L	COMP
** ********** SUB-TECHNOLOGY: SEMICONDUCTOR SILICON AVALANCHE PHOTODIODE (APD)							
07020 40201 A SBLC	INTERNAL GAIN --- NONE --- IMPR. DIR: H	QUANTUM EFFICIENCY --- NONE --- IMPR. DIR: H	EXCESS NOISE FACTOR --- NONE --- IMPR. DIR: L	DARK CURRENT --- nA --- IMPR. DIR: L	GAIN BANDWIDTH PRODUCT --- GHz --- IMPR. DIR: H	--- --- IMPR. DIR:	COMP
** ********** SUB-TECHNOLOGY: GaAs P-I-N PHOTODIODES							
07020 40202 A SBLC	QUANTUM EFFICIENCY --- NONE --- IMPR. DIR: H	DARK CURRENT --- pA --- IMPR. DIR: L	BANDWIDTH --- GHz --- IMPR. DIR: H	--- --- IMPR. DIR:	--- --- IMPR. DIR:	--- --- IMPR. DIR:	COMP
** ********** SUB-TECHNOLOGY: PHOTOMULTIPLIER TUBE (PMT)							
07020 40203 A SBLC	GAIN --- NONE --- IMPR. DIR: H	QUANTUM EFFICIENCY --- NONE --- IMPR. DIR: H	DARK CURRENT --- nA (NANOAMPS) --- IMPR. DIR: L	EXCESS NOISE --- NONE --- IMPR. DIR: L	--- --- IMPR. DIR:	--- --- IMPR. DIR:	COMP

FIGURE 4-2 PARAMETER NAMES & UNITS REPORT

Page No. 1
01/07/93

TECHNOLOGY ASSESSMENT OFFICE - TRW SPECIAL PROGRAMS
JAPANESE TECHNOLOGY STUDY
DATABASE ENTRIES
TECHNOLOGY: SPACE BASED LASER COMMUNICATIONS

CTL # SHEET CODE REC #	R A N K	ORGANIZATION 1 LOCATION, PERSON, COMMENTS	ORGANIZATION 2 LOCATION, PERSON, COMMENTS	ORGANIZATION 3 LOCATION, PERSON, COMMENTS	ME ST PH SE	PAR 1 VALUE NOTES	PAR 2 VALUE NOTES	PAR 3 VALUE NOTES	PAR 4 VALUE NOTES	PAR 5 VALUE NOTES	PAR 6 VALUE NOTES	SOURCE INFO DT PAGE ID WDT,CTY
** ********** SUB-TECHNOLOGY: HIGH-POWER SEMICONDUCTOR DIODE LASER												
06010 10400 A SBLC 27	C	COMMUNICATION RESEARCH LABORATORY, MINISTRY OF POSTS AND TELECOMMUNICATIONS ---- KOGANEI-SHI, TOKYO, JAPAN ---- M.SHIKATANI, S. YOSHIKADO, Y. ARIMOTO ---- SEE MEMO	COMMUNICATIONS RESEARCH LABORATORY, MINISTRY OF POSTS AND TELECOMMUNICATIONS ---- KOGANEI-SHI, TOKYO, JAPAN ---- Y.SUZUKI, Y.TAKAHASHI & T.ARUGA ----	NEC & TOSHIBA ---- ---- ---- SEE PAGE#:B016A & B001A	Y P RD U	0.83 ----	030 ----	----	----	----	----	JEY/121 6-01/00 1 01/14/9 0 B015B 01/01/9 1 JA
06010 10400 A SBLC 22	C	MATSUSHITA ELECTRONICS CORP., ELECTRONICS RESEARCH LABORATORY ---- TAKATSUKI, OSAKA 569, JAPAN ---- H.NAITO, M.KUME, K.HAMADA, G.KANO ---- S. MEHERLE HAS VERIFIED THAT THIS ARTCLE PERTAINES TO LASER COM.	MATSUSHITA ELECTRONICS CORP., ELECTRONICS RESEARCH LAB. ---- TAKATSUKI, OSAKA 569, JAPAN ---- H.SHIMIZU ----	---- ---- ----	Y A DT U	0.833 ---- AT 120mW STABLE FUNDAM ENTAL TRANSV ERSE MODE UP TO 120mW	0100 ---- MAXIMU M OUTPUT POWER OF 300mW UNDER CW OPERAT ION WAS ACHIEV ED	051 ----	----	----	----	JEN/VOL 25 86/0143 5 06/01/8 9 B013A / / JA
06010 10400 A SBLC 16	C	MITSUBISHI ELECTRIC CORP., CENTRAL RESEARCH LABORATORY ---- 1-1,TSUKAGUCHI-HON MACHI, 8-CHOME, AMAGASAKI, HYOGOG 661, JAPAN ---- KEISUKE KOJIMA, KUNIHIKO HARA & K.KYUMA ---- THIS ARTICLE WAS REVEIWED BY S. MEHERLE AND DOES APPLY TO SBLC	---- ---- ----	---- ---- ----	Y A DT U	0.86 ---- LINEWI DTH - 1.5MHz	----	----	----	----	----	JBV/04-24-89/0 238 04/24/8 9 B008A / / JA

FIGURE 4-3 DATABASE ENTRY REPORT (PRIMARY ENTRIES)

The first column contains the CTL # on the first two lines followed by the SHEET #, then the TECH CODE and finally the REC number.

The next three columns provide data on the first, second and third (A, B and C) organizations listed in the entry. First they list the organization name, then the list of names of principal researchers, and finally the comments on each organization.

The next column provides four pieces of data. First, a "Y" or "N" to indicate the existence of a memo field, next the STATUS (actual {A} or planned {P}), next the PHASE of the development (RD, DT, TT, PE, PP, or FP), and finally the security classification of the entry (U, C, or S)

The next six columns contain the values for each of the parameters identified in the Parameter Name Report described above. These columns also contain the notes relating to those parameter values. The user should correlate the sub-technology name (prefaced by a row of asterisks - in both reports) and the CTL & SHEET numbers between this Database Entry Report and the Parameter Name Report, in order to understand the name and units of each parameter, for which a value has been listed.

The last column contains the source identification, the date of information, the PAGE number, the "WHEN" date, and the CTRY (country) designation.

4.4 Database Entries for Secondary Reports

This report form is called "SECOND" in the dBase III+ report form structure. It is identical in structure and output to the Database Entry Report described above, except that it is titled "Database Entries for Secondary Reports" and it has been used by TAO in Volume 3 of this report, to present a listing of <u>only</u> secondary reports. This selectivity was accomplished by employing the "search condition" that field P be equal to "S". An example of this form is shown in Figure 4-4.

4.5 Database Entry Notes (Memo Fields) Report

This report is called "MEMO" in the dBase III+ report form structure. It is organized and grouped first by CTL # & SHEET #, which corresponds to the sub-technology headings that are prefaced by a row of asterisks. Within that group it is then ordered by the organization names. Each memo field is prefaced by the record (REC) number and by the security classification.

Page No. 1
01/07/93

TECHNOLOGY ASSESSMENT OFFICE - TRW SPECIAL PROGRAMS
JAPANESE TECHNOLOGY STUDY
DATABASE ENTRIES FOR SECONDARY REPORTS
TECHNOLOGY: SPACE BASED LASER COMMUNICATIONS

CTL # / SHEET / CODE / REC #	R / A / N / K	ORGANIZATION 1 / LOCATION, / PERSON, / COMMENTS	ORGANIZATION 2 / LOCATION, / PERSON, / COMMENTS	ORGANIZATION 3 / LOCATION, / PERSON, / COMMENTS	NE / ST / PH / SE	PAR 1 / VALUE / NOTES	PAR 2 / VALUE / NOTES	PAR 3 / VALUE / NOTES	PAR 4 / VALUE / NOTES	PAR 5 / VALUE / NOTES	PAR 6 / VALUE / NOTES	SOURCE / INFO DT / PAGE ID / WDT,CTY
** ********** SUB-TECHNOLOGY: HIGH-POWER SEMICONDUCTOR DIODE LASER												
00010	C	NATIONAL SPACE	---- ---- ----	---- ---- ----	Y	.850-1	----	----	----	----	----	JAJ/07-
10400		DEVELOPMENT AGENCY				.3						20-89/0
A		OF JAPAN, (NASDA)			P	----						07
B015B		---- TOKYO 105,				850NM						07/20/8
SBLC		JAPAN ---- HIDEO			RD							7
		OBA ----										B001A
9					U							/ /
												JA
00010	B	NEC CORPORATION,	COMMUNICATIONS	---- ---- ----	Y	0.83	----	----	----	----	----	JET/121
10400		SPACE & LASER	RESEARCH			----						0-56/00
A		COMMUNICATIONS	LABORATORY,		A							1
B015B		DIVISION ---- 4035	MINISTRY OF POSTS									01/14/9
SBLC		IKEBE-CHO,	AND		DT							0
		MIDORI-KU,	TELECOMMUNICATIONS									B016A
31		YOKOHAMA 226,	---- 4-2-1		U							/ /
		JAPAN ----	MUKUI-KITA-MACHI,									JA
		M.SHIMIZU,	KONGANEI-SHI,									
		K.SHIRATAMA &	TOKYO 184, JAPAN									
		Y.OHGUSHI ---- SEE	---- M.SHIKATANI,									
		MEMO- POINT AHEAD	Y.ARIMOTO &									
		MECHANISM FOR	T.ARUGA ----									
		ETS-VI OPTICAL ISL										
		EXPERIMENT										
** ********** SUB-TECHNOLOGY: SPACE BASED LASER COMMUNICATIONS												
00010	E	COMMUNICATIONS	COMMUNICATIONS	---- ---- ----	Y	----	----	----	----	----	----	JDZ/E05
20200		RESEARCH	RESEARCH			SEE						.2/0150
A		LABORATORY,	LABOARTORY,		P	MEMO						
B015A		MINISTRY OF POSTS	MINISTRY OF POSTS									10/16/8
SBLC		&	&		RD							9
		TELECOMMUNICATIONS	TELECOMMUNICATIONS									B010A
18		---- 4-2-1	---- 4-2-1		U							01/01/9
		MUKUI-KITA-MACHI,	MUKUI-KITA-MACHI,									3 JA
		KOGANEI, TOKYO	KOGANEI, TOKYO									
		184, JAPAN ----	184, JAPAN ---- Y.									
		T.ARUGA,	ARMITO & Y. SUZUKI									
		M.SHIKATANI,	----									
		S.YOSHIKADO ----										

FIGURE 4-4 DATABASE ENTRIES FOR SECONDARY REPORTS

These memo fields are limited to 5,000 characters by the dBase III+ program structure and are generally material that has been copied from the original source document with TAO's optical character reader (OCR). They may contain some typographical errors that were introduced during the OCR transfer.

An example of this report is illustrated in Figure 4-5.

```
Page No.     1
05/09/90
                TECHNOLOGY ASSESSMENT OFFICE - TRW SPECIAL PROGRAMS
                          JAPANESE TECHNOLOGY STUDY
                       DATABASE ENTRY NOTES (MEMO FIELDS)
                   TECHNOLOGY: SPACE BASED LASER COMMUNICATIONS


** ******** SUB-TECHNOLOGY: HIGH-POWER SEMICONDUCTOR DIODE LASER

* ** ORG: COMMUNICATION RESEARCH LABORATORY, MINISTRY OF POSTS AND TELECOMMUNICATI
 REC:  (U)

 27        SEE PAGE# B015A FOR DETAILS

* ** ORG: MATSUSHITA ELECTRONICS CORP., ELECTRONICS RESEARCH LABORATORY
 REC:  (U)

 22        Abstract - Long life GaAlAs lasers with 100mW fundamental
           transverse mode operation have been developed. This excellent
           degree of operation has been attained by using the non-absorbing
           mirrors for suppression of mirror degradation and a thin
           substrate structure for stabilization of the transverse mode. It
           has been found that under 100mW CW operation at 50 deg. C,
           degradation is insignificant even after 6000 h.

* ** ORG: MITSUBISHI ELECTRIC CORP., CENTRAL RESEARCH LABORATORY
 REC:  (U)

 16        Summarizing: Mitsubishi Electric Corp. fabricated narrow line
           width MQW DFB lasers. The minimum line width was 1.5 MHz, which
           is believed to be the narrowest value ever reported for
           AlGaAs/GaAs DFB lasers. This is due to the MQW structure, long
           cavity, and small confinement factor. The reduction of alpha in
           MQW DFB lasers compared with bulk DFB lasers was experimentally
           confirmed.  Detailed calculation and other methods of narrowing
           the line width are also present.
```

FIGURE 4-5 EXAMPLE OF THE DATABASE ENTRY NOTES REPORT

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

5.0 LIST OF PRINCIPAL ORGANIZATIONS IN EACH TECHNOLOGY

The following list of organizations for each of the ten technologies, was compiled by TAO based upon their prominence in the database as evidenced by multiple primary records, describing a number of achievements in the sub- technology. The asterisks, which were used to differentiate the most prominent organizations generally represent those organizations that were awarded achievement ranks of A and/or B by TAO analysts.

The total quantity of records in the database (both unclassified and classified) for each technology is listed in parenthesis after the name of each of the ten basic technologies. For example, there are a total of 16 records on the diskette for Voice & Data Communications Encryption.

A. VOICE & DATA COMMUNICATIONS ENCRYPTION (16)

I. Company

1. Hitachi Ltd.
2. Kokusai Denshin Denwa Co., Ltd.
3. Matsushita Electric Industrial Co ***.
4. NEC Corporation ***

II. Government Agencies

1. None reported

III. Institutions & Universities

1. Kobe University
2. Kyushu Institute of Technology
3. Saga University
4. The University of Electro-Communications ***
5. Tokyo Institute of Technology ***
6. Waseda University
7. Yokohama University

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

B. SPACE BASED LASER COMMUNICATIONS (42)

I. Company

1. Hamamatsu Photonics K.K.
2. Matsushita Electronics Corporation, ERL ***
3. Mitsubishi Electric Corporation, CRL ***
4. NEC Corporation ***
5. Omron Tateisi Electronics Corporation, CRL
6. Sony Corporation
7. Toshiba Corporation

II. Government Agencies

1. Ministry of Posts and Telecommunications ***
2. National Space Development Agency of Japan ***
3. Science and Technology Agency

III. Institutions & Universities

1. Shizuoka University ***
2. Tokyo Institute of Technology ***

C. SYNTHETIC APERTURE RADAR FOR SPACE BASED REMOTE SENSING (28)

I. Company

1. Mitsubishi Electric Corporation ***
2. NEC Corporation ***
3. Sumitomo Metal Mining Company, Ltd.
4. Toshiba Corporation

II. Government Agencies

1. National Space Development Agency of Japan ***
2. Ministry of International Trade and Industry ***
3. Science and Technology Agency

III. Institutions & Universities

1. Institute of Space & Astronautical Science

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

D. ATTITUDE CONTROL SYSTEMS FOR HEAVY SPACECRAFT (105)

I. Company

1. Fujitsu, Ltd
2. Hamamatsu Photonics K.K.
3. Hitachi, Ltd.
4. Ishikawajima-Harima Heavy Industries ***
5. Japan Aviation Electronics ***
6. Mitsubishi Electric Corporation, CRL ***
7. Mitsubishi Precision Co.
8. NEC Corporation, Space Development Div. ***
9. Nippon Oil & Fat, Ltd.
10. Nippon Suiyaku Kogyo
11. Sharp Corporation, CRL
12. Toshiba Corporation ***

II. Government Agencies

1. Ministry of Posts and Telecommunications ***
2. National Space Development Agency of Japan ***
3. Optoelectronic Industry & Development Assoc.

III. Institutions & Universities

1. Institute of Space & Astronautical Science
2. Matsushita Research Institute ***
3. Tohoku University
4. University of Osaka Prefecture ***
5. University of Tokyo

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

E. IR DETECTORS & FOCAL PLANE ARRAYS (133)

I. Company

1. Fujitsu, Ltd. ***
2. Hamamatsu Photonics K.K. ***
3. Hitachi, Ltd., Central Research Laboratory ***
4. Mitsubishi Electric Corporation ***
5. NEC Corporation, Space Development Div.***
6. Optical Science Company, Ltd
7. Sumitomo Heavy Industries, Ltd
8. Sumitomo Metal Mining Co., Ltd
9. Toshiba Corporation

II. Government Agencies

1. Defense Agency's Technical R&D Institute
2. Ministry of International Trade & Industry
3. National Space Development Agency of Japan ***
4. Science and Technology Agency

III. Institutions & Universities

1. Institute of Space & Astronautical Science
2. Shizuoka University ***
3. Tsukuba College of Technology
4. University of Tokyo ***
5. University of Tsukuba ***

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

F. X-RAY LITHOGRAPHY (94)

I. Company

1. Dai Nippon Printing Co., Ltd..
2. Electrotechnical Laboratory ***
3. Furukawa Electric Co.
4. Hitachi, Ltd.
5. Hoya Corporation
6. Mitsubishi Electric Co. ***
7. NEC Corporation
8. Nippon Telephone & Telegraph Corporation ***
9. Photon Factory
10. Sanyo Electric Company
11. SORTEC - joint venture 13 companies ***
12. Sumitomo Electric Industries, Ltd. ***
13. Toppan Printing Company, Ltd.

II. Government Agencies

1. Ministry of International Trade & Industry
2. SCUBA - Government Research Office ***

III. Institutions & Universities

1. Japan Atomic Energy Research Institute
2. Osaka University ***
3. Tohohu University
4. University of Tokyo ***

G. E-BEAM LITHOGRAPHY (22)

I. Companies

1. Fujitsu, Ltd. ***
2. Hitachi, Ltd ***
3. Joel, Ltd
4. Nippon Telegraph & Telephone
5. Toshiba Corporation ***

II. Government Agencies

1. None Reported

III. Institutions & Universities

1. None Reported

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

H. DIAMOND COATINGS AND FILMS (120)

I. Company

1. Ashai Diamond Industrial Company
2. Cannon
3. Fujitsu Laboratories ***
4. Idemitsu Petrochemical
5. Japan Synthetic Rubber Company
6. Kanagawa Prefecture Industrial Lab.
7. Kobe Steel ***
8. Kyoei Plastic Company
9. Matsushita Electric Industrial Co.
10. Mitsubishi Product Development Laboratory ***
11. Nippon Oil & Fats
12. Onoda Cement Company, Ltd.
13. Osaka Diamond Industrial
14. Seiko Instruments & Electronics, Ltd.
15. Showa Denko
16. Sony Corporation
17. Sumitomo Chemical Company ***
18. Sumitomo Electric Industries ***

II. Government Agencies

1. National Research Laboratory & Metrology

III. Institutions & Universities

1. Aoyama Gakuin University ***
2. National Research Institute for Inorganic Material ***
3. Nippon Institute of Technology ***
4. Osaka University ***
5. Tokai University
6. Tokyo Institute of Technology ***
7. Tokyo University
8. Toyohashi University

SURVEY OF ADVANCED TECHNOLOGIES IN JAPAN - FINAL REPORT

I. HIGH SPEED DATA PROCESSING (50)

I. Company

1. Fujitsu, Ltd. ***
2. Hitachi, Ltd ***
3. NEC Corporation ***
4. Nippon Electric Company
5. Sony Corporation ***

II. Government Agencies

1. None Reported

III. Institutions & Universities

1. None Reported

J. HIGH RESOLUTION FLAT PANEL DISPLAYS (71)

I. Company

1. Dixi Corporation (Fuji Electronics Corp.)
2. Fubuta Corporation, Ltd.
3. Fujitsu, Ltd.
4. Hitachi, Ltd.
5. Japan Aviation Electronics ***
6. Mitsubishi Electric Corporation ***
7. Oki Electric Industries
8. Seiko Epson Corporation
9. Sharp Electronics Corporation
10. Toshiba Corporation
11. Yokogawa Electric Corporation

II. Government Agencies

1. National Aerospace Laboratory of Science & Technology

III. Institutions & Universities

1. None Reported

6.0 DATABASE USER'S GUIDE

6.1 INSTALLATION

STEP	INSTRUCTIONS
A	CREATE A NEW SUB-DIRECTORY ON YOUR HARD DISK, CALLED "DBASE".
B	FLOPPY NO.1 CONTAINS THE dBASE & CTAS PROGRAMS, FORMAT AND SCREEN FILES AND A BATCH FILE TO START THE WHOLE APPLICATION. COPY: JAPAN.BAT TO YOUR ROOT DIRECTORY AND THEN COPY ALL THE FILES TO YOUR NEW DBASE SUB-DIRECTORY.
C	TEN FLOPPIES, A THRU J, CONTAIN ALL THE CTAS FILES FOR EACH OF THE 10 TECHNOLOGIES. THESE 3 1/2 DISKETTES EACH HAVE A 1.2 MEG CAPACITY. DO NOT USE THESE MASTERS - MAKE A COPY OF EACH. INSERT THE COPY OF YOUR CHOICE INTO YOUR "A:" FLOPPY DRIVE WHENEVER YOU START A SESSION.

NOTE: IF YOU MUST USE THE "B:" FLOPPY DRIVE, INSTEAD, YOU MUST REVISE THE 3RD AND 8TH LINES IN "SETUP.PRG", AND THE DEFAULT LINE IN CONFIG.DB (USING THE COPY CON COMMAND OF DOS - SEE BATCH FILE COMMANDS), BOTH FILES ARE IN YOUR DBASE SUB-DIRECTORY

WHEN REVISING THE CONFIG.DB FILE IT IS BEST TO FIRST PRINT IT ON YOUR SCREEN USING THE COMMAND "TYPE C:\DBASE\CONFIG.DB" AND THEN USE THE COMMAND "COPY CON C:\DBASE\CONFIG.DB" TO CAREFULLY COPY EACH LINE OF THAT FILE WITH YOUR CHANGES. COMPLETE YOUR NEW CONFIG.DB FILE WITH THE F6(KEY) .... & ENTER (KEY), ON THE LAST LINE OF THE FILE. REPEAT THE TYPE COMMAND, ABOVE, TO CHECK AND VERIFY YOUR CHANGE.

THE COLORS OF YOUR DISPLAY SCREEN CAN ALSO BE CHANGED BY REVISING THE "COLOR=" LINE OF THE CONFIG.DB FILE. REFER TO A DBASE III+ HANDBOOK FOR THE COLOR CODES.

6.2 OPERATIONS

STEP	INSTRUCTIONS
1	TO START SESSION, AT C: PROMPT
2	ENTER: JAPAN .....& ENTER (KEY)
3	ENTER: ESC (KEY)
4	AT . PROMPT
5	ENTER: DO C:SETUP .....& ENTER (KEY) (THIS SETS UP BOTH THE QUEST AND ANSW DATABASES TO WORK TOGETHER ON THE EDIT SCREEN, WHICH YOU WILL USE) IMPORTANT: WITHOUT THIS STEP, THE DATABASE WILL BE INOPERATIVE

6 IF YOU WANT TO SEE ALL RECORDS SKIP TO STEP 10

7 TO SELECT A FILTER FOR FILE:
USE KEYPAD TO SELECT "SETUP-QUERY" FROM MENU BAR
8 ENTER: ENTER (KEY)....TWICE
9 CHOOSE "PRIMARY" TO SEE JUST THOSE RECORDS...& ENTER (KEY)
OR "BLFILES" TO SEE ONLY BASELINE RECORDS....& ENTER (KEY)

10 TO INSPECT INDIVIDUAL RECORDS:
USE KEYPAD TO SELECT "UPDATE-EDIT".....& ENTER (KEY)

11 THIS IS THE FIRST RECORD, EITHER IN THE ENTIRE FILE OR IN A TEMPORARY FILE THAT HAS BEEN FILTERED BY THE QUERY THAT YOU MAY HAVE CHOSEN IN STEP 9

12 TO READ ANY FIELD THAT IS PARTIALLY HIDDEN, USE THE KEYPAD TO MOVE CURSOR TO THAT FIELD AND THEN USE RIGHT ARROW OF KEYPAD TO SCROLL WITHIN THAT FIELD

REPEAT STEP 12 FOR ANY OTHER FIELDS DESIRED

13 TO VIEW A MEMO FIELD:

A USE KEYPAD TO MOVE CURSOR TO THE FIELD ON THE THIRD LINE, FOLLOWING THE FIELD LABEL "DESCR:", WHICH CONTAINS THE WORD "MEMO"
B ENTER: CTRL (KEY) + PGDN (KEY) (JOINTLY)
C USE KEYPAD TO INSPECT MEMO FIELD
D WHEN DONE INSPECTING THE MEMO FIELD, ENTER: CTRL (KEY) + PGUP (KEY) (JOINTLY)
E YOU WILL BE RETURNED TO THE EDIT SCREEN FOR THAT RECORD

14 TO EDIT OR APPEND A MEMO FIELD:

A YOU SHOULD BE AWARE THAT THE dBASE III+ MEMO FIELD IS STRICTLY LIMITED TO NO MORE THAN 5,000 CHARACTERS. IT WILL WARN YOU JUST BEFORE YOU HIT THE LIMIT AND THEN REFUSE ANY ADDITIONAL CHARACTERS. YOU CAN CIRCUMVENT THAT LIMITATION BY CREATING ANOTHER RECORD WITH THE SAME CTL NUMBER AND THE SAME PAGE NUMBER AND THE SAME ENTRY FOR ORGANIZATION 1, CONTINUE YOUR MEMO ON THAT RECORD FOR ANOTHER 5,000 CHARACTERS AND CROSS REFERENCE IT TO THE OTHER RECORD.
B THE WINDOW REPRODUCED BELOW LISTS THE EDITING OPTIONS AVAILABLE AND THE PROPER KEYS. THE FIRST AND SECOND BOXES DESCRIBE HORIZONTAL AND VERTICAL CURSOR MOTION RESPECTIVELY WHILE THE THIRD BOX COVERS DELETIONS. THERE ARE ALSO OPTIONS FOR REFORMAT, FIND AND REFIND, AND YOU CAN READ OR WRITE AN ASCII FILE FROM OR TO THE

FLOPPY DIRECTORY. SAVE YOUR CHANGES OR ADDITIONS WITH A 8^(CTRL) W.

Edit: INFO

CURSOR: <-- -->	UP DOWN	DELETE	Insert Mode: Ins
Char: ← →	Line: ↑ ↓	Char: Del	Insert line: ^N
Word: Home End	Page: PgUp PgDn	Word: ^T	Save: ^W Abort: Esc
Line: ^← ^→	Find: ^KF	Line: ^Y	Read file: ^KR
Reformat: ^KB	Refind: ^KL		Write file: ^KW

15 TO PRINT A MEMO FIELD: IF THE ENTRY IN THE "DESCR:" FIELD (ON 3RD LINE) IS "T", THAT MEANS THERE IS A MEMO FIELD ASSOCIATED WITH THIS RECORD. TO PRINTOUT JUST THAT MEMO, OR ALL THE MEMOS IN THE FILE OR ANY SELECTION OF MEMOS GO TO STEP 20C5, BELOW.

AT CONCLUSION OF PRINTING PRESS ANY KEY AND THEN USE KEYPAD TO RETURN TO "UPDATE-EDIT".....& ENTER (KEY)

16 TO MOVE TO THE NEXT RECORD: ENTER: PGDN (KEY) OR PGUP (KEY) FOR PREVIOUS RECORD

17 TO LEAVE RECORDS: ENTER: ESC (KEY)

18 TO GO TO A PARTICULAR RECORD NUMBER:
A USE KEYPAD TO SELECT "POSITION-GO TO RECORD"
B ENTER: ENTER (KEY)
C USE KEYPAD TO CHOOSE "RECORD".....& ENTER (KEY)
D ENTER: NUMBER OF RECORD (E.G. 6)...& ENTER (KEY)
E USE KEYPAD TO RETURN TO "UPDATE-EDIT" ON MENU
F ENTER: ENTER (KEY)

19 BEFORE PRINTING A REPORT, YOU SHOULD USE THE "POSITION-GO TO RECORD" AND SELECT "TOP" TO PLACE THE POINTER AT THE BEGINNING OF THE INDEXED FILE, UNLESS YOU SPECIFICALLY WANT TO START AT A PARTICULAR RECORD NUMBER.

20 TO PRINT A REPORT:
A USE KEYPAD TO SELECT "RETRIEVE-REPORT" ON MENU
B ENTER: ENTER (KEY) (TWICE)
C CHOOSE DESIRED REPORT FORM:

1 "SUMMARY" PRINTS A LIST OF ALL RECORDS

2 "ANSW" PRINTS ALL THE RECORDS IN THE FILE (RESTRICTED BY WHATEVER QUERY FILTER YOU HAVE MOST RECENTLY SET, DURING THIS SESSION

3 "QUEST" PRINTS THE PARAMETER NAMES AND UNITS FOR ALL THE RECORDS IN THE FILE (AS RESTRICTED BY ANY QUERY FILTER YOU MAY HAVE SET)

4 "SECOND IS A SPECIAL REPORT FORMAT THAT CAN BE USED TO PRINT ALL THE SECONDARY RECORDS IN THE FILE, OR FOR JUST PRINTING THE SECONDARY RECORDS ASSOCIATED WITH A PARTICULAR PRIMARY RECORD. (TO USE THIS, BE SURE THAT NO QUERY FILTERS ARE SET - OR GO THRU A "SETUP" AGAIN - STEP 5). TO PRINT A SECONDARY REPORT:

a WITH "SECOND" SELECTED...ENTER (KEY)
b USE KEYPAD TO SELECT "BUILD A SEARCH CONDITION".....& ENTER (KEY)
c USE UP ARROW OF KEYPAD TO SELECT "REF"....& ENTER(KEY)
d USE ENTER (KEY) TO SELECT "=EQUAL TO"
e ENTER THE PAGE NO. OF THE PRIMARY RECORD FOR WHICH YOU WANT TO PRINT THE RELATED SECONDARY RECORDS. YOU CAN FIND THE PAGE NO. IN THE "SUMMARY LISTING" REPORT ON SHEET 21 OF THE BRIEFING. THE 7TH COLUMN (REF#, ETC) CONTAINS THE REF NO., WHICH IS ALSO THE PAGE NO. OF THE RELATED PRIMARY REPORT. IN THIS FILE ALL REF NO. BEGIN WITH "B" TO IDENTIFY THEM TO "SPACE BASED LASER COMMUNICATIONS", THE TECHNOLOGY COVERED IN THIS DEMO DISK FILE. ALSO NOTICE THAT AN "S" IN THE 5TH COLUMN IDENTIFIES ALL SECONDARY REPORTS WHILE A "P" IDENTIFIES ALL PRIMARY REPORTS IN THIS FILE.
f ENTER: ENTER (KEY) AND USE KEYPAD TO SELECT "NO MORE CONDITIONS" ... & ENTER (KEY), THEN USE KEYPAD TO SELECT "EXECUTE THE COMMAND" ..... & ENTER (KEY)
g ENTER "Y" (KEY) TO REQUEST PRINTOUT
h AT COMPLETION, PRESS ANY KEY (PER SCREEN INSTRUCTIONS)

5 "MEMO" CAN BE USED TO PRINT OUT ALL OF THE MEMO FIELDS IN THE ENTIRE FILE FOR THAT TECHNOLOGY (IN THE SAME ORDER THAT THEY ARE INDEXED AND APPEAR IN THE "SUMMARY" AND "ANSW" REPORT FORMS) OR IT CAN BE USED TO SELECTIVELY PRINTOUT A SINGLE MEMO FIELD OR ANY CLASS THAT YOU CHOOSE TO SPECIFY, THROUGH EITHER THE "SCOPE" OR "SEARCH" CONDITIONS THAT dBASE MAKES AVAILABLE TO YOU.

IMPORTANT PRINTER INFORMATION: THE MEMO REPORT AND SUMMARY REPORT WILL BOTH PRINT ON AN 8 1/2 x 11

INCH FORMAT BUT YOU MUST HAVE YOUR PRINTER SET FOR 12 CHARACTERS PER INCH.

a SELECT "MEMO" .....ENTER (KEY)

b IF YOU WANT ALL MEMO FIELDS PRINTED GO TO STEP c DIRECTLY BELOW

c USE THE KEYPAD TO SELECT "EXECUTE THE COMMAND" ....& ENTER (KEY), THEN ENTER "Y" (KEY)

d IF YOU WANT SOME SELECTION OF MEMO FIELDS PRINTED YOU MAY EITHER SPECIFY SCOPE OR BUILD A SEARCH CONDITION.

e TO SPECIFY SCOPE, USE THE KEYPAD TO SELECT "SPECIFY SCOPE" ....& ENTER (KEY)

f YOU MUST NEXT CHOOSE YOUR SCOPE. THE "DEFAULT SCOPE" WILL PRINT ALL MEMOS IN THE FILE. IF YOU CHOOSE "NEXT" YOU WILL BE REQUIRED TO SPECIFY A QUANTITY (E.G. 6) AND WILL GET PRINTOUTS OF THE NEXT 6 MEMO FIELDS. IF YOU CHOOSE "RECORD" YOU MUST THEN SPECIFY THE RECORD NUMBER AND JUST THAT MEMO FIELD WILL BE PRINTED. IF YOU SELECT "REST" MEMOS FOR THE REST OF THE FILE, STARTING AT THE CURRENT RECORD, WILL BE PRINTED. USE THE KEYPAD TO MAKE YOUR SELECTION ....& ENTER (KEY), THEN GO TO STEP 5c ABOVE.

g TO ESTABLISH SEARCH CONDITIONS, SELECT "BUILD A SEARCH CONDITION" .....& ENTER (KEY)

h YOU CAN NOW SELECT ANY FIELD (REFER TO THE FIELD NAME CROSS REFERENCE LIST IN THIS REPORT) BY HIGHLIGHTING IT ...& ENTER (KEY)

i YOU CAN THEN SPECIFY WHETHER YOU WANT THE VALUE IN THAT FIELD TO BE MORE, LESS, EQUAL TO, OR NOT EQUAL TO, A VALUE THAT YOU SPECIFY. JUST SELECT ...& ENTER (KEY).

j NOW SELECT "NO MORE CONDITIONS" OR CHOOSE TO COMBINE IT WITH ANOTHER CONDITION IN EITHER AN "AND" OR AN "OR" CONFIGURATION ...& ENTER (KEY).

k WHEN YOU FINALLY CHOOSE "NO MORE CONDITIONS" GO TO STEP 5c ABOVE.

E IMPORTANT PRINTER INFORMATION: WITH THE EXCEPTION OF THE SUMMARY REPORT AND THE MEMO REPORT, ALL OTHERS (QUEST, ANSW, & SECOND) ARE 164 COLUMNS WIDE WITH A 16 COLUMN WIDE LEFT MARGIN. THEY CAN BE PRINTED ON AN 8 1/2 X 11 PAGE, USING A LASER PRINTER, SET FOR A LANDSCAPE FONT WITH A PITCH OF 16.6 CHARACTERS PER INCH AND A FONT SIZE OF 8.5 POINTS.

ANOTHER ALTERNATIVE IS TO USE THE dBASE DOT PROMPT COMMAND: .REPORT FORM A:ANSW (OR QUEST OR SECOND, DEPENDING ON THE REPORT YOU WANT PRINTED) TO FILE A:[YOUR FILENAME]. dBASE WILL PRINT AN ASCII TEXT FILE ON DISKETTE A: UNDER THE FILENAME YOU SPECIFY. YOU CAN THEN USE "SIDEWAYS" TO PRINT THAT TEXT FILE ON YOUR NARROW FORMAT PRINTER.

21 USE KEYPAD TO CHOOSE OTHER DBASE OPTIONS

22 WHEN ENDING SESSION ALWAYS SELECT "SETUP-QUIT dBASE III PLUS ".....& ENTER (KEY)

23 NOTE: SHOULD YOU EVER FIND YOURSELF AT THE DOT PROMPT (.) IN dBASE AND YOU WANT TO RETURN TO THE MENU DRIVEN MODE, ENTER: ASSIST.....& RETURN (KEY)

6.3 HELP

SHOULD YOU REQUIRE ANY HELP IN INSTALLING OR TESTING AND USING THIS DATABASE, PLEASE CALL: SHEP KANAREK, AT TRW. (213)535-2558. IF NO ANSWER, PLEASE LEAVE A MESSAGE AT (213)536-1642.

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

TRW TECHNOLOGY CONSULTANT RESUME

TECHNOLOGY: HIGH-RESOLUTION FLAT PANEL DISPLAYS

TRW CONSULTANT: HARRY CAMPBELL

RESUME IS NOT AVAILABLE

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

TRW TECHNOLOGY CONSULTANT RESUME

TECHNOLOGY: SYNTHETIC APERTURE RADAR FOR SPACE-BASED REMOTE SENSING

TRW CONSULTANT: LEOPOLD J. CANTAFIO

EDUCATION:

University of Alabama
B.S. in Electrical Engineering, 1952

University of Southern California
M.S., Systems Management, 1971

University of Pennsylvania
M.S., Electrical Engineering (Courses completed 1959)

WORK EXPERIENCE:

TRW, Applied Technology Division (1983 - Present)

Senior Staff Engineer, Program Manager, LARST Study, a high-power MMW space-based radar for SDI

Advanced radar system studies including MMW phased-array

Radar conceptual designs, Re-entry Vehicle Radar, ECCM, Rendezvous Radar, DMSP weather radar, LORRA and TRAMAR space-based weather radar antennas.

Advanced radar studies for space-based, ground-based, airborne and shipboard radars at he Aerospace Corp.

The Aerospace Corporation (1965-1983)

Staff Engineer, Performed advanced radar system studies for space based, ground Bbsed, airborne shipborne, and RV- borne radars.

The Raytheon Company (1960-1965)

Principal Scientist, Performed advanced radar systems development of space, ground, shipborne radars for use in AICBM, air defense, Over-The-Horizon detection, space tracking and range instrumentation missions.

Radio Corporation of America (RCA) (1952-1960)
Class A Engineer, Conducted design, development, production

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

and system engineering of airborne, shipborne and ground based military systems including AP Q35B/ APS-57/, Black Cat, MA-10, Aero IIB, Bomarc Data Link, TRADEX, DAMP, Project Mercury.

ACTIVITIES AND AWARDS:

Member IEEE AESS - Radar Systems Panel

Chairman of Space Based Radar Committee for IEEE AESS

Member IEEE, Air Force Association, Theta Tau

Guest Lecturer at University of Southern California

Guest Lecturer at George Washington University

Guest Lecturer at West Coast University Graduate School, Course 522.

Lecturer in Aerospace & TRW after hours course Radar Systems

Guest Lecturer at Air Force Academy for Dept. of Astronautics and Computer Sciences, 1976-1982.

Nominated in 1982 for Engineering Group MTS Award at Aerospace Corp.

Listed in Who's Who in the West, 1980-81

PUBLICATIONS: (Selected List)

Survivability/Vulnerability of the Space Surveillance Radar Sensors For The Space Defense System Program". October 1980. TOR-0081 (6435-01)-1, The Aerospace Corporation.

"Preliminary Design of Alternate SBR Systems." January 10, 1980. ATM-80(5909-10)-4 The Aerospace Corporation.

"Millimeter Wave Technology Study," April 23, 1979, ATM-79(4417-01)-I, The Aerospace Corporation.

"Postulated Description, Performance and Comparison of An Ocean Surveillance Satellite." October 12, 1978. Also presented at the 24th Annual Tri-Service Radar Symposium in Monterey, California TOR-0078 (3790)-1 The Aerospace Corporation.

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

"Space Based Radar", Military Electronics/Countermeasures, November 1977.

"Space Based Radar-Past, Present and Future Developments". SAMSO TR-77-30. The Aerospace Corporation. TR-0076 (6901-02)-2, August 27, 1976. Also presented at the 22nd Annual Tri-Service Radar Symposium, Colorado Springs, July 1976.

"Preliminary Design of a Multi-Function Space Based Radar For Reusable Launch Vehicle Application." ATM-76(6451-11)-I.

Chapter 8 "Range Instrumentation Ships" in Range Instrumentation. Published by Prentice Hall Inc., 1967.

"Prediction of the Minimum-Investment Cost of Phased Array Radars. IEEE Trans. on Aerospace and Electronic Systems. Vol. AES-3, No. 6, November 1967, also presented at EASTCON 1967.

"Satellite-Borne Radar Concept For Air Traffic Surveillance". IEEE Electro '82 Convention Record, May 25, 1982. Radar Systems Session.

"Space-Based Radar for The Proposed United Nations International Satellite Monitoring Agency", Microwave Journal, Vol 27. No 12. December 1984. p.115ff.

"Radar Surveillance Data for Aircraft, Missiles, Satellites and Surface Ships (U)", The Aerospace Corp. TOR-0083 (3415-02)-4, dated 31 Mar. 1983.

Contributing author of text "Range Instrumentation" published by Prentice-Hall Inc., 1967.

Contributing author, "Radar Handbook", M. I. Skolnik ed. McGraw-Hill 19 @, revised edition.

Editor/Author, "Space Based Radar Handbook," Artech House, 1989.

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

TRW TECHNOLOGY CONSULTANT RESUME

TECHNOLOGY: IR DETECTORS AND FOCAL PLANE ARRAYS

TRW CONSULTANT: GARY E. GRIMM

EDUCATION:

University of Chicago
B.A. with honors, Mathematics and Physics.

Yale University
M.S., Particle Physics.

University of Oregon
Ph.D. Low Temperature Physics.

WORK EXPERIENCE:

TRW (1983 to present)

Division Senior Staff Engineer, Military and Science Payloads Office

Assistant Program Manager, Payload Design and Analysis for a multimillion-dollar advanced satellite subsystem. Responsible for cost, schedule, and technical performance of TRW and subcontractor

Lead Systems Engineer, Acquisition and Track Sensor for SDS and SBKEW programs. Responsible for hardware design and analysis including optical, mechanical, electronic, thermal and data processing subsystems. Directed and coordinated subcontractors. Performed target and background phenomenology calculations

Lead Systems Engineer for receiver design, Laser Imaging Component Development proposal. Directed and coordinated subcontractors. Improved receiver performance 30% by use of mosaic focal plane array and novel local oscillator coupling

Principal Investigator for internal research and development efforts in radiation hardness, electro-optics, and satellite subsystems, Received IR&D award

Technical consultant for payload design on Agile Beam Director, SLCSAT, SOARS, Laser Crosslink, Lightning Mapper, advanced DSP, SSTS, and BSTS proposals

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

Hughes Aircraft Company (1979 to 1983)

Staff Physicist, Electro-Optic and Data Systems Group, Increased performance of two major electro-optical subsystems by 30% through studies of charge transport and noise reduction. Presented results at Washington, D.C. conference and obtained patent. Noise model used as performance prediction tool on five current programs

Analyzed the effect of signal processing on information transmission, modulation, and noise of three large scale space-based electro-optical systems. Study resulted in an average 50% improvement in signal to noise

Determined the effect of device physics on overall satellite system performance for four major programs

Participated in the development and analysis of six space-based electro-optical systems and three ground-based systems

Expanded the design and analysis of two laser systems. Work included the study of beam propagation and beam detection

Coordinated a study of radiation hardness of electro-optical systems which improved hardness an order of magnitude

Directed research and development tasks on MOSFET Noise and improved photovoltaic detectors

University of Oregon, School of Business Admin. (1977 to 1979

Evaluation coordinator for the Federal Small Business Administration Experimental Center for the Advancement of Innovation and Invention

Coordinated marketing and technical assistance for small businesses and independent inventors

University of Oregon, Department of Physics (1973 to 1979)

Research Associate, Teaching Assistant, Researched transport in condensed matter and quantum fluids

Lectured to 140 students, taught an advanced class of 20, and tutored individuals

Brookhaven Laboratory (1971 to 1973)

Research Assistant, Researched high energy proton-matter interactions. Implemented and maintained proton beam target.

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

PATENTS:

One on low noise, high value semiconductor resistors

PUBLICATIONS:

Five on various topics. One in Italian

LANGUAGES:

Fluent German, working knowledge of Italian, Chinese, Japanese, Russian, and French

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

TRW TECHNOLOGY CONSULTANT RESUME

TECHNOLOGY: HIGH-SPEED DATA PROCESSING

TRW CONSULTANT: SHI-PING HSU

EDUCATION:

California Institute of Technology, Pasadena, California
Ph.D. in Electrical Engineering, September 1979
M.S. in Electrical Engineering, June 1977
B.S. in Physics, June 1973

National Taiwan University, Taipei, Taiwan, Republic of China

WORK EXPERIENCE:

TRW (April 1983 - Present)

Manager of Technology Development, Engineering Centers
Principal Investigator of the FISC IR&D Project
Co-principal Investigator of FISC IR&D Project

As Manager of Technology Development, Hsu is responsible for the development of two advanced technology development programs; the Fast Image and Signal Computer (FISC) and the Fast Data Finder (FDF) projects. FISC is a high speed I/O computer designed for capturing, storing and managing large quantities of images and signals. Applications include NASA's Earth Observing System and a classified data archive and distribution system. The system will interface to the fastest network and mass storage devices to be available in the near future.

FISC's fast memory and I/O processors are many times faster than any commercially available products. Many custom VLSI chips and unique packaging techniques were developed for this computer.

FDF is a high speed text scanning machine, capable of searching text at 10 million characters per second. Applications include automatic key fact extraction, information dissemination, genetic and intelligence database search.

ACTIVITIES AND AWARDS

TRW Chairman's Award for Innovation, June 21, 1989.

PATENTS

"Fast Search Processor", United Sates Patent 4,760,523, 1988

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

TRW TECHNOLOGY CONSULTANT RESUME

TECHNOLOGY: SPACE-BASED LASER COMMUNICATIONS

TRW CONSULTANT: G. STEPHEN MECHERLE

EDUCATION:

University of Southern California, Los Angeles, California
Ph.D. Degree in Electrical Engineering, May 1986;
Dissertation: "Maximized data rate capability for optical communication using semiconductor devices with pulse position modulation";

University of Southern California, Los Angeles, California
Engineer Degree in Electrical Engineering, May 1982

University of Illinois, Urbana, Illinois
M.S. Degree in Electrical Engineering, May 1978; Master's Thesis: "Speckle noise in direct detection LIDAR systems"

University of Illinois, Urbana, Illinois
B.S. Degree in Electrical Engineering, May 1977

WORK EXPERIENCE:

TRW (October 1987 - Present)

Senior Staff Engineer, Electronic Systems Group, System Engineering Lab -
Provided senior system engineering review for NASA Direct Detection Laser Transceiver laser communication flight program; conducted comprehensive technical review and developed link budgets for operational space laser communication system; major task leader for program to evaluate communication and radar applications for advanced laser diode technology; developed complete direct detection free space lasercom simulation package

Hughes Aircraft Company (1978 - 1987)

Electro-Optical and Data Systems Group, Laser and Control Systems Laboratories (1980-1987) -
Optical diffraction and re-imaging analysis for wavefront error sensor; theoretical analysis of laser speckle effects on active tracking systems; Major task leader on USAF program responsible for experimental evaluation of laser diode pulsed power capabilities, with subsequent analytical optimization of PPM lasercom system based on observed performance; System

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

engineer for electro-optical systems to support NASA space station tracking system, including sensors for laser docking and video tracking/range triangulation;

Program Manager for NASA semiconductor laser combining system design study; major task leader for life test/reliability and consultant for technology on space laser diode assembly hardware program; product line responsibility for Laser Diode Systems

Head, Electro-Optical Analysis section, April 1986; laser radar system analysis for SDI/classified programs including several laser sources;

Program Manager, USAF AFWAL Laser Communication Test System, program to deliver prototype automatic tracking and automatic acquisition lasercom hardware for aircraft applications; major task leader for classified program

Space and Communication Group (78-80) -
Developed theoretical design parameters and built wideband tunable high pressure RF-excited CO2 waveguide local oscillator laser;

Project engineer for wideband CO2 coherent detection homodyne phase-locked Costas receiver, including overall lasercom system analog and digital performance evaluation; communication design responsibility for satellite lasercom crosslink; performed system architecture tradeoffs for high data rate satellite lasercom

University of Illinois Electrical Engineering Department -
Research Assistant (5/77-6/78) - Evaluation of system parameters related to speckle noise in direct detection LIDAR systems;

Teaching Assistant, Microwave Lab, fall '77, Coherent Optics Lab, spring '78;

ACTIVITIES AND AWARDS

Honorary and Technical Societies:
Phi Eta Sigma; Eta Kappa Nu; Tau Beta Pi; Phi Kappa Phi; Member IEEE, Member SPIE

Awards:
Hughes Aircraft Engineer Fellowship
Doctoral Fellowship
Outstanding Paper Award of 1984 - "Signal speckle effects on optical detection with additive Gaussian noise," JOSA A,

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

Vol. 1, pp. 68-72, January 1984;
Hughes achievement award for contributions to NASA laser communication study program award (1983)

PUBLICATIONS

G. S. Mecherle, "Signal speckle effects on optical detection with dditive Gaussian noise," Journal of the Optical/ Society of America A, Vol. 1, January 1984, pp. 68-72.

J. D. Barry and G. S. Mecherle, "LPI optical communication system," 1984- IEEE Military Communications Conference, Los Angeles, October 1984, pp. 259-262.

J. D. Barry, A. J. Einhorn, G. S. Mecherle, P. Nelson, R. A. Dye, and W. J. Archambeault, "Thermally accelerated life testing of single mode, double-heterostructure, AlGaAs laser diodes operated pulsed at 50 mW peak power," IEEE Journal of Quantum Electronics, Vol. QE-21, No. 4, April 1985, pp. 365-376.

G. S. Mecherle, "Impact of laser diode performance on data rate; capabilities of PPM optical communication," 1985 IEEE Military Communications Conference, Boston, October 1985, pp. 115-121.

J. D. Barry and G. S. Mecherle, "Beam pointing error as a significant design parameter for satellite-borne, free-space optical communication systems," Optical Engineering, November/December 1985, Vol. 24, No. 6, pp. 1049-1054.

G. S. Mecherle, "Detection alternatives for pulse position modulation (PPM) optical communication," Proceedings of SPIE Vol. 616, Los Angeles, January 1986, pp. 105-116.

J. D. Barry and G. S. Mecherle, "Communication channel burst errors induced by Gaussian distributed mispointing," Proceedings of SPIE Vol. 616, Los Angeles, January 1986, pp. 137- 140.

G. S. Mecherle, "Laser diode combining for free space optical communication," Proceedings of SPIE Vol. 616, Los Angeles, January 1986, pp.281-291.

G. S. Mecherle and J. H. Engleman, "Considerations for accelerated laser diode life testing," Proceedings of SPIE Vol. 717, Cambridge, September 1986, pp. 53-62.

G. S. Mecherle, "Docking/berthing sensor using a laser diode rangefinder, CCD and video tracker," Proceedings of SPIE Vol. 887, Los Angeles, January 1988, pp. 88-95.

G. S. Mecherle and J. D. Barry, "Laser communication terminals with automatic video tracking," Proceedings of SPIE Vol. 885, Los Angeles, January 1988, pp. 153-163.

G. S. Mecherle, A. K. Rue and G. T. Pope, "Automatic Tracking and Acquisition for Laser Communication Using Video Techniques," 1988 IEEE Military Communications Conference, San Diego, October 1988, pp. 543-555.

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

TRW TECHNOLOGY CONSULTANT RESUME

TECHNOLOGY: DIAMOND COATINGS AND FILMS

TRW CONSULTANT: JOHN R. OGREN

EDUCATION:

Northern Michigan University
BS. Physics, 1955

Iowa State University
M.S. Physics, 1957
PH. D Physical Metallurgy, 1965
National Science Foundation Fellow, 1960
Ford Foundation Fellow, 1964

Case Institute of Technology
General Electric Fellow, 1958

University of California - Davis
Atomic Energy Comm Fellow, 1959

WORK EXPERIENCE:

TRW (1965 - Present)

Senior Staff Scientist, Power & Propulsion Laboratory, Applied Technology Division, Space & Technology Group

Dr. Ogren has spent his entire industrial research career in the development and characterization of new materials.

In the 1960's he developed ultra-high temperature materials for containment of radiosotope thermoelectric heat sources for use in space missions far away from the sun. His work led directly to the RTG power sources used in Pioneer 10 and 11 satellites that have now gone beyond the planet Saturn, and have left our solar system. The same RTG power sources are used on special satellites (LES-8) for near earth orbit.

From 1974 to 1977, Dr. Ogren was assigned to TRW's Washington DC Energy Office where he co-authored a volume of President Nixon's "Project Independence Blueprint'. His responsibility was to define materials research that was needed by the nation in order to insure a supply of abundant energy.

From 1977 to 1988, Dr Ogren was Chief Metallurgist on a large Uranium Isotope Separation Program at TRW for DOE. Numerous

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

special aspects were involved; his interactions were with all of the DOE National Laboratories.

Since 1988, Dr Ogren has been actively involved in the growth and characterization of carbon films, including diamond, diamond-like carbon (DLC) and simply disordered carbon films. In parallel, he has necessarily maintained close contact with a closely related thin film technology involving B. SiC.

By virtue of his affiliation in the Power and Propulsion Laboratory, he also maintains close contact with high temperature combustion materials technology involving both solid and liquid bipropellant propulsion systems.

Northern Michigan University

Assistant Professor, Physic, 1957 - 1960

California Polytechnic State University

Assistant Professor, Physics, 1960 - 1965

ACTIVITIES:

Adjunct Professor, Mathematics, El Camino College, Torrance, Ca.

Editor-in-Chief, Journal of Materials Engineering, a quarterly archive publication of ASM and Springer Verlag.

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

TRW TECHNOLOGY CONSULTANT RESUME

TECHNOLOGY: VOICE & DATA COMMUNICATIONS ENCRYPTION

TRW CONSULTANT: PAUL F. SMITHA

EDUCATION:

University of California, Los Angeles
BS, Electrical Engineering, Jan 1963
Graduate work in digital computer logic design

WORK EXPERIENCE:

TRW (1965 - Present)

Senior Staff Engineer, Digital Development Laboratory
Digital communication systems electrical design including signal processing, high speed digital processing and COMSEC equipment

Sustaining Engineer, Projects 5396, 7857 & 7777 digital electronics

Subsystem Engineer, CEP/MPE digital electronics

Subproject Manager, CEP/MPE Multiplexers. Includes the development of the Wideband Digital Multipexer (WDM) . Responsible for all payload high speed digital equipment during the proposal and advanced studies phase of the program.

Supported Bandyman COMSEC architecture study. Responsible for digital hardware concepts.

SPM on project 5396, responsible for development of the ACSU and upgrading of the DPU which includes high-speed 3/D conversion and multiplexing.

SPM for electrical development of TIU/MPU digital equipment on MSPL Program.

Subsystem Engineer for Wideband Privacy System.

Sr. Staff Engineer, Special Digital Processors, Electronic Development Operations.

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

Section Head, Digital Development Laboratory. Assignments included TDRSS digital bit synchronizers, Batson II AVE digital processors, GPS receiver architecture studies, and TED program COMSEC processor.

MTS, Signal Processing Department. Digital circuit and logic design.

Ramo Woolridge/Bunker Ramo Corporation (1965-1965)

Circuit design for special purpose digital computers.

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

TRW TECHNOLOGY CONSULTANT RESUME

TECHNOLOGY: ATTITUDE CONTROL SYSTEMS FOR HEAVY SPACECRAFT

TRW CONSULTANT: VICTOR A. SPECTOR

EDUCATION:

University of Southern California
PhD, Mechanical Engineering

Massachusetts Institute of Technology
MS, BS, Electrical Engineering,

WORK EXPERIENCE:

TRW

Member of the Senior Staff in S&TG's Controls, Sensors, and Mechanisms Laboratory

Principal Investigator on IR&D project for Precision Control of Agile Spacecraft. Advancing and integrating structural design, active and passive damping, system identification, and control technology to achieve both rapid slewing and precision pointing of large flexible spacecraft. Designing and constructing multi-body flexible test facility to verify modeling and performance of slew, pointing, shape control, and vibration control components and systems

Principal Investigator on IR&D project for Robotics Control Laws and Sensor Technology. Developed analytical methods for modeling flexible robotic manipulators with non-colocated sensors and actuators. Determined control implications sensitivity of model to perturbations in structural properties and sensor/actuator locations. Designed and constructed flexible manipulator with integrated multi-point optical deflection sensor

Advanced X-Ray Astrophysics Facility (AXAF) Pointing Control and Attitude Determinations Subsystem Engineer. Designed control system for large maneuvering spacecraft with sub arc-second pointing knowledge and jitter requirements and non-colocated sensors and actuators. Developed pointing and jitter simulations including detailed external and internal (reaction wheel) disturbance models

Head of the Advanced Technology Section of the Control System Engineering Department. Responsible for up to 15 control

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

engineers. Led development of early LSS control technology. Directed team designing precision pointing system

Principal Investigator on IR&D Project for Autonomous Spacecraft Navigation, Attitude Determination, and Control. Developed techniques for autonomous navigation using landmark tracking and spacecraft/spacecraft ranging. Developed methods for on-board identification and diagnosis of attitude determination and attitude control system failures.

Principal Investigator on IR&D project for Control Moment Gyro (CMG) Technology. Developed detailed models of single gimbal CMGs. Designed and simulated CMG control system including steering laws and flexible spacecraft dynamics. Verified modeling through air bearing motion test

Designed pointing control systems for spacecraft including HEAO, FLTSATCOM, TDRSS, GRO, OMV, and numerous classified programs.

ACTIVITIES:

Member of AIAA, IEEE

PUBLICATIONS:

Author of 14 technical publications.

APPENDIX 1 - RESUMES OF TRW TECHNOLOGY CONSULTANTS

TRW TECHNOLOGY CONSULTANT RESUME

TECHNOLOGY: X-RAY LITHOGRAPHY & E-BEAM LITHOGRAPHY

TRW CONSULTANT: RICHARD N. TAUBER

RESUME IS NOT AVAILABLE

DR. TAUBER IS COAUTHOR OF THE TEXTBOOK:

SILICON PROCESSING FOR THE VLSI ERA,
VOLUME 1: PROCESS TECHNOLOGY

LATTICE PRESS, SUNSET BEACH, CA. 1986

APPENDIX 2 - MILITARILY CRITICAL TECHNOLOGIES LIST (PARTIAL)

CTL No	TECHNOLOGIES
0100000000	Information Systems and Networks
0102000000	Information Processing
0102050000	HIGH SPEED DATA PROCESSING (I) **********
0200000000	Computer Hardware
0205000000	Digital Computer Display & Workstation
0205010000	Alphanumeric & Graphic Display Devices
0205010300	HIGH-RESOLUTION FLAT PANEL DISPLAYS (J) ***
0300000000	Computer Software
0400000000	Automated Control of Industrial Systems
0500000000	Materials and Production
0600000000	Directed Energy and Kinetic Energy Systems
0700000000	Semiconductor and Electronic Component
0701000000	Microcircuit
0701010000	Wafer Preparation
0701020000	Epitaxy Process
0701030000	Insulation Process
0701040000	Maskmaking
0701050000	Lithographic
0701050301	E-BEAM LITHOGRAPHY (G) **********
0701050302	X-RAY LITHOGRAPHY (F) **********
0601060000	Selective Removal
0701070000	Diffusion/Implantation
0701080000	Thin-Film Deposition
0701090000	Microcircuit Assembly
0701100000	Microcircuit Testing
0701110000	Microcircuit Production Facilities
0701120000	Monolithic IC Design
0701130000	Microwave Millimeter Integrated Circuits (MMIC)
0702000000	Discrete Solid-State Device
0702010000	Discrete Transistor
0702020000	Semiconductor Diode
0702030000	Thyristor
0702040000	Semiconductor Detector
0702040200	IR DETECTORS & FOCAL PLANE ARRAYS (E) ******
0703000000	Microcircuit Packaging
0703010000	Printed Circuit (PC) Board
0703020000	Hybrid Microcircuit
0704000000	Electronic Material
0704010000	Preparation, Purification, Compounding and Handling of Electronic, Electro-optic, and Optical Materials

APPENDIX 2 - MILITARILY CRITICAL TECHNOLOGIES LIST (PARTIAL)

CTL No	TECHNOLOGIES
0704010200	DIAMOND COATINGS & FILMS (H) **********
0704020000	Bulk and Epitaxial Crystal Growth
0705000000	Acoustic Wave Device
0706000000	Photomultiplier Tube and Image Intensifier
0706010000	Photomultiplier Tube
0706020000	Image Intensifier
0707000000	Passive Component
0707010000	Ferrite Material and Device
0707020000	Strontium Titanate Monolithic Ceramic Capacitors
0707030000	High Energy Density Capacitor
0707040000	Quartz Crystal
0708000000	Superconducting and Cryogenic Component
0708010000	Superconducting Digital Component
0708020000	Cryogenic Cooling
0708030000	Thermoelectric Cooler
07080400000	Superconducting Material
0800000000	Instrumentation
0900000000	Telecommunications
0901000000	Telecommunications Systems
0901020000	Optical Communications
0901020200	SPACE-BASED LASER COMMUNICATIONS (B) ******
0907000000	VOICE & DATA COMMUNICATIONS ENCRYPTION (A) ******
1000000000	Communications, Navigation, Guidance, Control and Identification
1100000000	Microwave/Millimeterwave
1200000000	Vehicular
1206000000	Spacecraft
1206040000	Low-THrust Spacecraft Propulsion
1206040100	ATTITUDE CONTROL SYSTEMS FOR HEAVY SPACECRAFT (D) **********
1300000000	Optical
1400000000	Sensor
1407000000	Radar and Signal Intercept Related
1407010000	SYNTHETIC APERTURE RADAR FOR SPACE-BASED REMOTE SENSING (C) **********
1500000000	Undersea Systems
1600000000	Chemicals and Biotechnology
1700000000	Nuclear Related Technology

APPENDIX 2 - MILITARILY CRITICAL TECHNOLOGIES LIST (PARTIAL)

CTL No	TECHNOLOGIES
1800000000	Reserved
1900000000	Energy Systems
2000000000	Energetic Materials and Devices

APPENDIX 3 - CROSS-REFERENCE LIST OF FIELD NAMES

THIS IS A CONVERSION CHART FOR FIELD NAMES USED IN DBASE III+ STRUCTURE VERSUS THE FIELD LABELS THAT APPEAR ON THE DATA ENTRY/EDIT SCREEN

THESE ARE THE NAMES TO USE TO CONSTRUCT A "FIELD LIST" FOR ANY COMMAND OR TO IDENTIFY A FIELD NAME WHEN CONSTRUCTING A "QUERY"

DBASE III+ OFFICIAL FIELD NAME (IN ANSW.DBF)	FIELD LABEL THAT APPEARS ON EDIT SCREEN	LINE NO. ON SCREEN
TECHNO	CTL	1
PAGENO	PAGE	6
SHEET	SHEET #	2
DESCRAPPLC	MEMO	8
MEMFLG	DESCR	7
SOURCECODE	SOURCE	6
INFODATE	INFO	6
CLASS	SECURITY	8
ACPLDATE	WHEN	8
STATUS	STATUS	8
PHASE	PHASE	8
RSCHR	ANALY	8
CTRY	CTRY	6
PERSON1	NAME-A	11
ORG1	ORGANIZATION-A	11
LOC1	LOCATION-A	11
COMMENT1	COMMENTS-A	11
PERSON2	NAME-B	12
ORG2	ORGANIZATION-B	12
LOC2	LOCATION-B	12
COMMENT2	COMMENTS-B	12
PERSON3	NAME-C	13
ORG3	ORGANIZATION-C	13
LOC3	LOCATION-C	13
COMMENT3	COMMENTS-C	13
VAL1	VALUE-1	16
VAL2	VALUE-2	17
VAL3	VALUE-3	18
VAL4	VALUE-4	19
VAL5	VALUE-5	20
VAL6	VALUE-6	21
NOTE1	NOTES-1	16
NOTE2	NOTES-2	17
NOTE3	NOTES-3	18
NOTE4	NOTES-4	19
NOTE5	NOTES-5	20
NOTE6	NOTES-6	21
BLANK	(USED ONLY IN REPORT FORMATTING)	
PS	P	6
ACH	L	6

APPENDIX 3 - CROSS-REFERENCE LIST OF FIELD NAMES

REF	REF	6

APPENDIX 3 - CROSS-REFERENCE LIST OF FIELD NAMES

THE FOLLOWING FIELDS ARE CONTAINED IN THE "QUEST.DBF" DATABASE, WHICH IS THE RELATIONAL DATABASE COUPLED WITH ANSW.DBF. IT IS USED TO RETAIN THE PARAMETER NAMES, AND UNITS FOR EACH ELEMENT OR SUB-TECHNOLOGY. WHILE IT IS VERY UNLIKELY THAT YOU WOULD NEED THESE FIELD NAMES FOR THE QUERY FUNCTION OR OTHER FUNCTIONS THAT YOU MIGHT USE, THEY ARE AS FOLLOWS.

DBASE III+ OFFICIAL FIELD NAME	FIELD LABEL THAT APPEARS ON EDIT SCREEN	LINE NO. ON SCREEN
(IN QUEST.DBF)	----------	--
TECHNO ***	CTL	1
TECHNOLOGY	CAT	4
TECHNAME	SUB TECH	4
SHEET ***	SHEET #	2
NAME1	PARAMETER-1	16
NAME2	PARAMETER-2	17
NAME3	PARAMETER-3	18
NAME4	PARAMETER-4	19
NAME5	PARAMETER-5	20
NAME6	PARAMETER-6	21
UNIT1	UNITS-1	16
UNIT2	UNITS-2	17
UNIT3	UNITS-3	18
UNIT4	UNITS-4	19
UNIT5	UNITS-5	20
UNIT6	UNITS-6	21
IMPR1	B-1	16
IMPR2	B-2	17
IMPR3	B-3	18
IMPR4	B-4	19
IMPR5	B-5	20
IMPR6	B-6	21
BLANK	(USED ONLY FOR REPORT FORMAT)	

*** TECHNO AND SHEET ARE THE KEY FIELDS THAT TIE ANSW.DBF AND QUEST.DBF TOGETHER IN THE RELATIONAL DATABASE.

APPENDIX 4 - LIST OF DATA SOURCE CODES - A: (CODE ORDER)

Page No. 1
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JAA	SCIENCE & TECHNOLOGY PERSPECTIVES	
JAB	QUEST	
JAC	C&EN	
JAD	LASER SATELLITE COMMUNICATIONS	
JAE	PHYSICAL REVIEW B	
JAF	INTRODUCTION TO AIRBORNE RADAR	
JAG	IEEE ELECTRON DEVICE LETTER	
JAH	JAPANESE JOURNAL OF APPLIED PHYSICS	
JAI	JOURNAL OF VACUUM SCIENCE TECHNOLOGY A	
JAJ	JPRS REPORT SCIENCE AND TECHNOLOGY	
JAK	SCIENCE AND TECHNOLOGY IN JAPAN	***
JAL	MAUAL OF REMOTE SENSING VOLUME I	
JAM	INFRARED HANDBOOK	
JAN	OPTICAL INDUSTRY AND SYSTEMS PURCHASING DIRECTORY	
JAO	SCIENTIFIC INFORMATION BULLETIN	
JAP	DEFENSE SCIENCE	
JAQ	JOURNAL OF LIGHTWAVE TECHNOLOGY	
JAR	1988 IEEE 11th INTERNATIONAL SEMICONDUCTOR LASER CONFERENCE	
JAS	OPTICAL ENGINEERING	
JAT	CRYOGENICS	

APPENDIX 4 - LIST OF DATA SOURCE CODES - A: (CODE ORDER)

Page No. 2
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JAU	FAXES FROM TRW TOKYO OFFICE	***
JAV	HANDBOOK OF CRITICAL ELEMENTS & TECH.THAT MUST BE DEV.FOR SDI & ATM	
JAW	GYROS - TECHNICAL INFORMATION FOR ENGINEERS F00456	
JAX	AEROSPACE-JAPAN-WEEKLY	***
JAY	THE JAPAN ECONOMIC JOURNAL	***
JAZ	LETTERS: KOBE STEEL TO TRW	***
JBA	LASER WORLD	
JBB	LASER FOCUS	
JBC	NEW YORK TIMES	
JBD	THE ASIAN WALL STREET JOURNAL	***
JBE	MESSAGES: JAPAN RELATED INFORMATION SENT FROM CUSTOMER	
JBF	INSIDE R&D	
JBG	KOBE STEEL DIAMOND GROWTH CHART	***
JBH	NASDA BROCHURE-COMMUNICATION SATELLITE-CS-3	***
JBI	NASDA YEARLY BROCHURE	
JBJ	IEEE TRANSACTIONS ON ELECTRON DEVICES	
JBK	HITACHI TECHNOLOGY MAGAZINES	***
JBL	REVIEW OF SCIENTIFIC INSTRUMENTS	
JBM	ELECTRONICS NEWLETTERS	
JBN	IEEE TRANSACTIONS ON GEOSCIENCE & REMOTE SENSING	

APPENDIX 4 - LIST OF DATA SOURCE CODES - A: (CODE ORDER)

Page No. 3
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOURCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JBO	IEEE GEOSCIENCE & REMOTE SENSING SYMPOSIUM-ZURICH	
JBP	MOS-1 SATELLITE	***
JBQ	QUANTUM ELECTRONICS AND LASER CONFERENCE 1989	
JBR	12TH INTERNATIONAL CONFERENCE ON INFRARED & MILLIMETER WAVES 1987	
JBS	PROCEEDINGS FROM MATERIALS RESEARCH SOCIETY CONFERENCE	
JBT	AEROSPACE CENTURY XXI: SPACE MISSIONS AND POLICY 3 VOLUMES	
JBU	AIAA JOURNAL OF GUIDANCE, NAVIGATION AND CONTROL	
JBV	1989 LASER AND ELECTRO-OPTICS CONFERENCE	
JBW	INTERNATIONAL ELECTRON DEVICES MEETING 1987	
JBX	HAMAMATSU PRODUCT LITERATURE - PbSe & Pbs IR DETECTORS	
JBY	HAMAMATSU IR DETECTORS CATALOG	
JBZ	HAMAMATSU-Cds PHOTOCONDUCTIVE CELLS CATALOG	
JCA	HAMAMATSU - PHOTODIODES CATALOG	
JCB	HAMAMATSU - SPECIAL IMAGING TUBES CATALOG	
JCC	HAMAMATSU - IMAGING PICKUP TUBES	
JCD	HAMAMATSU - PHOTOMULTIPLIER TUBES	
JCE	APPLIED PHYSICS LETTERS	

APPENDIX 4 - LIST OF DATA SOURCE CODES - A: (CODE ORDER)

Page No. 4
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JCF	THIN SOLID FILMS	
JCG	BSE SATELLITE BROCHUE	***
JCH	PROCEEDINGS FROM THE 38TH CONGRESS OF I.A.F.	
JCI	EXPERIMENTAL GEODETIC PAYLOAD BROCHURE	
JCJ	SONY SEMICONDUCTOR BROCHURE	
JCK	MISUBISHI ELECTRONIC CORPORATION SPACE ACTIVITIES	***
JCL	MISUBISHI SATELLITE ANTENNA	***
JCM	JAPANESE MAGNETIC BEARING FLYWHEEL FOR SPACE USE	***
JCN	SPACE TECHNOLOGY - INDUSTRIAL AND COMMERCIAL APPLICATIONS	
JCO	SOLID STATE ELECTRONICS	
JCP	SIGNPOST SPACE ACTIVITIES - SCIENTIFIC SATELLITE #8 TENMA (ASTRO-B)	***
JCQ	SIGN POST SPACE ACTIVITIES - SCIENTIFIC SATELLITE #9 OHZORA (EXOS-C)	***
JCR	SIGNPOST SPACE ACTIVITIES - SCIENTIFIC SATELLITE MST5 SAKAIGAKE	***
JCS	H-I ROCKET BROCHURE	***
JCT	NASDA BROCHURE - GMS-3 SATELLITE	***
JCU	LAUNCHING & TRACKING/CONTROL OF MOS-1 BY N-LAUNCH VEHICLE #16	***
JCV	GUIDE TO RADIO GROUP -NEC	

APPENDIX 4 - LIST OF DATA SOURCE CODES - A: (CODE ORDER)

Page No. 5
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JCW	CCD STAR TRACKER - NEC	***
JCX	CCD RADIOMETER - NEC	***
JCY	IHI'S ACTIVITIES IN SPACE	***
JCZ	DEVELOPMENT OF MPD THRUSTER FOR SPACE USE - 16TH ISIS SAPPORO JAPAN	
JDA	ENGINEERING TEST SATELLITE -V	***
JDB	KOBELECO TECHNOLOGY REVIEW	***
JDC	IHI-MPD THRUSTER BROCHURE	***
JDE	SUMMARY OF JAPAN'S CURRENT MAJOR SPACE PROGRAMS	
JDF	LETTERS: FUJITSU LTD. TO TRW	***
JDG	SPACE TECHNOLOGY - FUJITSU	
JDH	FUJITSU TOKKI SYSTEMS LTD (TSL) BROCHURE	
JDI	14TH INTERNATIONAL SYMPOSIUM ON SPACE TECH. & SCIENCE	
JDJ	SPACE SENSOR EXPERIENCE	
JDK	OPTICS LETTERS	
JDL	NASA SP 804 SPACECRAFT SUN SENSORS	
JDM	SILICON PROCESSING FOR THE VLSI ERA VOL-I PROCESS TECHNOLOGY	
JDN	MICROELECTRONIC MANUFACTURING & TESTING PERIODICAL	
JDO	IEEE CURCUITS & DEVICES MAGAZINE	
JDP	SEMICONDUCTOR INTERNATIONAL PERIODICAL	

APPENDIX 4 - LIST OF DATA SOURCE CODES - A: (CODE ORDER)

Page No. 6
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JDQ	ELECTRONICS	
JDR	PRIVACY AND AUTHENTICATION - PROCEDDINGS OF IEEE VOL 67 #3	
JDS	SELECTED AREAS OF COMMUNICATIONS	
JDT	MEMO - HARRY CAMPBELL (TRW) WITH ENCLOSURES	***
JDU	FUJITSU BROCHURES - CORPORATION	
JDV	ELECTRONICS LETTERS	
JDW	1988 INTERNATIONAL DISPLAY RESEARCH CONFERENCE	
JDX	DAN BOETZ TELEPHONE CONVERSATION	***
JDY	JOURNAL OF VACUM TECHNOLOGY B	
JDZ	PROCEEDINGS FROM CLEO CONFERENCE IN FLORIDA 10/89	***
JEA	ELECTRONIC ENGINEERING	
JEB	EDN	
JEC	SPECTRUM	
JED	PHOTONICS	
JEE	TRW HIGH SPEED DATA PROCESSING EXPERT - SHI-PING-HSU	***
JEF	THE SUPERCOMPUTOR	
JEG	THE FUTURE OF INFORMATION PROCESSING TECHNOLOGY	
JEH	IEEE 1985 FIRST INTERNATIONAL CONFERENCE ON SUPERCOMPUTING SYSTEMS	
JEI	FUJITSU FLAT PANEL DISPLAY PRODUCT BROCHURE	

APPENDIX 4 - LIST OF DATA SOURCE CODES - A: (CODE ORDER)

Page No. 7
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JEJ	FUBUTA VFD DISPLAY PRODUCT BROCHURE	
JEK	TRW INTERVIEW - FRANK COULTER REGARDING TECHNOLOGY A	***
JEL	SEIKO LCD PRODUCT BROCHURE	
JEM	AIAA JOURNAL OF PROPULSION AND POWER	
JEN	IEEE JOURNAL OF QUANTUM ELECTRONICS	
JEO	IEEE COMPUTER	
JEP	OPTICAL FIBER SENSORS CONFERENCE 1988	
JEQ	ELECTRO-OPTICS & MILLIMETER-WAVE TECHNOLOGY IN JAPAN	
JER	ASHAI EVENING NEWS	***
JES	THE DESERT SUN	
JET	PC MAGAZINE	
JEU	IEEE-INTERNATIONAL SYMPOSIUM ON INFORMATION THEORY	
JEV	PROCEEDINGS SUPERCOMPUTING 1988	
JEW	PROCEEDING OF THE SID DTD:JAN. 88	
JEX	PROCEEDING OF SUPERCOMPUTER EUROPE 1989	
JEY	PROCEEDINGS OF LASE/90 CONFERENCE 1/14/90	***
JEZ	APPLIED OPTICS	
JFA	PROCEEDINGS OF IGARSS 84, STRAUSBURG	

APPENDIX 4 - LIST OF DATA SOURCE CODES - A: (CODE ORDER)

Page No. 8
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JFB	IEEE 8TH SYMPOSIUM ON MASS STORAGE SYSTEMS	
JFC	IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS	
JFD	TRW STUDY ON MASS STOREAGE DEVICES - JIM SOWDER	***
JFE	TRW E & T SYMPOSIUM - RECENT QUANTUM ELECTRONICS DEVELOPMENT IN JAPAN	***

APPENDIX 4 - LIST OF DATA SOURCE CODES - B: (ALPHABETICAL ORDER)

Page No. 1
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JBR	12TH INTERNATIONAL CONFERENCE ON INFRARED & MILLIMETER WAVES 1987	
JDI	14TH INTERNATIONAL SYMPOSIUM ON SPACE TECH. & SCIENCE	
JAR	1988 IEEE 11th INTERNATIONAL SEMICONDUCTOR LASER CONFERENCE	
JDW	1988 INTERNATIONAL DISPLAY RESEARCH CONFERENCE	
JBV	1989 LASER AND ELECTRO-OPTICS CONFERENCE	
JBT	AEROSPACE CENTURY XXI: SPACE MISSIONS AND POLICY 3 VOLUMES	
JAX	AEROSPACE-JAPAN-WEEKLY	***
JBU	AIAA JOURNAL OF GUIDANCE, NAVIGATION AND CONTROL	
JEM	AIAA JOURNAL OF PROPULSION AND POWER	
JEZ	APPLIED OPTICS	
JCE	APPLIED PHYSICS LETTERS	
JER	ASHAI EVENING NEWS	***
JCG	BSE SATELLITE BROCHUE	***
JAC	C&EN	
JCX	CCD RADIOMETER - NEC	***
JCW	CCD STAR TRACKER - NEC	***
JAT	CRYOGENICS	
JDX	DAN BOETZ TELEPHONE CONVERSATION	***
JAP	DEFENSE SCIENCE	

APPENDIX 4 - LIST OF DATA SOURCE CODES - B: (ALPHABETICAL ORDER)

Page No. 2
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JCZ	DEVELOPMENT OF MPD THRUSTER FOR SPACE USE - 16TH ISIS SAPPORO JAPAN	
JEB	EDN	
JEQ	ELECTRO-OPTICS & MILLIMETER-WAVE TECHNOLOGY IN JAPAN	
JEA	ELECTRONIC ENGINEERING	
JDQ	ELECTRONICS	
JDV	ELECTRONICS LETTERS	
JBM	ELECTRONICS NEWLETTERS	
JDA	ENGINEERING TEST SATELLITE -V	***
JCI	EXPERIMENTAL GEODETIC PAYLOAD BROCHURE	
JAU	FAXES FROM TRW TOKYO OFFICE	***
JEJ	FUBUTA VFD DISPLAY PRODUCT BROCHURE	
JDU	FUJITSU BROCHURES - CORPORATION	
JEI	FUJITSU FLAT PANEL DISPLAY PRODUCT BROCHURE	
JDH	FUJITSU TOKKI SYSTEMS LTD (TSL) BROCHURE	
JCV	GUIDE TO RADIO GROUP -NEC	
JAW	GYROS - TECHNICAL INFORMATION FOR ENGINEERS F00456	
JCS	H-I ROCKET BROCHURE	***
JCC	HAMAMATSU - IMAGING PICKUP TUBES	
JCA	HAMAMATSU - PHOTODIODES CATALOG	

APPENDIX 4 - LIST OF DATA SOURCE CODES - B: (ALPHABETICAL ORDER)

Page No. 3
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JCD	HAMAMATSU - PHOTOMULTIPLIER TUBES	
JCB	HAMAMATSU - SPECIAL IMAGING TUBES CATALOG	
JBY	HAMAMATSU IR DETECTORS CATALOG	
JBX	HAMAMATSU PRODUCT LITERATURE - PbSe & Pbs IR DETECTORS	
JBZ	HAMAMATSU-Cds PHOTOCONDUCTIVE CELLS CATALOG	
JAV	HANDBOOK OF CRITICAL ELEMENTS & TECH.THAT MUST BE DEV.FOR SDI & ATM	
JBK	HITACHI TECHNOLOGY MAGAZINES	***
JEH	IEEE 1985 FIRST INTERNATIONAL CONFERENCE ON SUPERCOMPUTING SYSTEMS	
JFB	IEEE 8TH SYMPOSIUM ON MASS STORAGE SYSTEMS	
JEO	IEEE COMPUTER	
JDO	IEEE CURCUITS & DEVICES MAGAZINE	
JAG	IEEE ELECTRON DEVICE LETTER	
JBO	IEEE GEOSCIENCE & REMOTE SENSING SYNPOSIUM-ZURICH	
JEN	IEEE JOURNAL OF QUANTUM ELECTRONICS	
JFC	IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS	
JBJ	IEEE TRANSACTIONS ON ELECTRON DEVICES	
JBN	IEEE TRANSACTIONS ON GEOSCIENCE & REMOTE SENSING	

APPENDIX 4 - LIST OF DATA SOURCE CODES - B: (ALPHABETICAL ORDER)

Page No. 4
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JEU	IEEE-INTERNATIONAL SYMPOSIUM ON INFORMATION THEORY	
JCY	IHI'S ACTIVITIES IN SPACE	***
JDC	IHI-MPD THRUSTER BROCHURE	***
JAM	INFRARED HANDBOOK	
JBF	INSIDE R&D	
JBW	INTERNATIONAL ELECTRON DEVICES MEETING 1987	
JAF	INTRODUCTION TO AIRBORNE RADAR	
JAH	JAPANESE JOURNAL OF APPLIED PHYSICS	
JCM	JAPANESE MAGNETIC BEARING FLYWHEEL FOR SPACE USE	***
JAQ	JOURNAL OF LIGHTWAVE TECHNOLOGY	
JDY	JOURNAL OF VACUM TECHNOLOGY B	
JAI	JOURNAL OF VACUUM SCIENCE TECHNOLOGY A	
JAJ	JPRS REPORT SCIENCE AND TECHNOLOGY	
JBG	KOBE STEEL DIAMOND GROWTH CHART	***
JDB	KOBELECO TECHNOLOGY REVIEW	***
JBB	LASER FOCUS	
JAD	LASER SATELLITE COMMUNICATIONS	
JBA	LASER WORLD	
JCU	LAUNCHING & TRACKING/CONTROL OF MOS-1 BY N-LAUNCH VEHICLE #16	***
JDF	LETTERS: FUJITSU LTD. TO TRW	***

APPENDIX 4 - LIST OF DATA SOURCE CODES - B: (ALPHABETICAL ORDER)

Page No. 5
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JAZ	LETTERS: KOBE STEEL TO TRW	***
JAL	MAUAL OF REMOTE SENSING VOLUME I	
JDT	MEMO - HARRY CAMPBELL (TRW) WITH ENCLOSURES	***
JBE	MESSAGES: JAPAN RELATED INFORMATION SENT FROM CUSTOMER	
JDN	MICROELECTRONIC MANUFACTURING & TESTING PERIODICAL	
JCK	MISUBISHI ELECTRONIC CORPORATION SPACE ACTIVITIES	***
JCL	MISUBISHI SATELLITE ANTENNA	***
JBP	MOS-1 SATELLITE	***
JDL	NASA SP 804 SPACECRAFT SUN SENSORS	
JCT	NASDA BROCHURE - GMS-3 SATELLITE	***
JBH	NASDA BROCHURE-COMMUNICATION SATELLITE-CS-3	***
JBI	NASDA YEARLY BROCHURE	
JBC	NEW YORK TIMES	
JAS	OPTICAL ENGINEERING	
JEP	OPTICAL FIBER SENSORS CONFERENCE 1988	
JAN	OPTICAL INDUSTRY AND SYSTEMS PURCHASING DIRECTORY	
JDK	OPTICS LETTERS	
JET	PC MAGAZINE	
JED	PHOTONICS	

APPENDIX 4 - LIST OF DATA SOURCE CODES - B: (ALPHABETICAL ORDER)

Page No. 6
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JAE	PHYSICAL REVIEW B	
JDR	PRIVACY AND AUTHENTICATION - PROCEDDINGS OF IEEE VOL 67 #3	
JEX	PROCEEDING OF SUPERCOMPUTER EUROPE 1989	
JEW	PROCEEDING OF THE SID DTD:JAN. 88	
JDZ	PROCEEDINGS FROM CLEO CONFERENCE IN FLORIDA 10/89	***
JBS	PROCEEDINGS FROM MATERIALS RESEARCH SOCIETY CONFERENCE	
JCH	PROCEEDINGS FROM THE 38TH CONGRESS OF I.A.F.	
JFA	PROCEEDINGS OF IGARSS 84, STRAUSBURG	
JEY	PROCEEDINGS OF LASE/90 CONFERENCE 1/14/90	***
JEV	PROCEEDINGS SUPERCOMPUTING 1988	
JBQ	QUANTUM ELECTRONICS AND LASER CONFERENCE 1989	
JAB	QUEST	
JBL	REVIEW OF SCIENTIFIC INSTRUMENTS	
JAA	SCIENCE & TECHNOLOGY PERSPECTIVES	
JAK	SCIENCE AND TECHNOLOGY IN JAPAN	***
JAO	SCIENTIFIC INFORMATION BULLETIN	
JEL	SEIKO LCD PRODUCT BROCHURE	
JDS	SELECTED AREAS OF COMMUNICATIONS	

APPENDIX 4 - LIST OF DATA SOURCE CODES - B: (ALPHABETICAL ORDER)

Page No. 7
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JDP	SEMICONDUCTOR INTERNATIONAL PERIODICAL	
JCQ	SIGN POST SPACE ACTIVITIES - SCIENTIFIC SATELLITE #9 OHZORA (EXOS-C)	***
JCP	SIGNPOST SPACE ACTIVITIES - SCIENTIFIC SATELLITE #8 TENMA (ASTRO-B)	***
JCR	SIGNPOST SPACE ACTIVITIES - SCIENTIFIC SATELLITE MST5 SAKAIGAKE	***
JDM	SILICON PROCESSING FOR THE VLSI ERA VOL-I PROCESS TECHNOLOGY	
JCO	SOLID STATE ELECTRONICS	
JCJ	SONY SEMICONDUCTOR BROCHURE	
JDJ	SPACE SENSOR EXPERIENCE	
JDG	SPACE TECHNOLOGY - FUJITSU	
JCN	SPACE TECHNOLOGY - INDUSTRIAL AND COMMERCIAL APPLICATIONS	
JEC	SPECTRUM	
JDE	SUMMARY OF JAPAN'S CURRENT MAJOR SPACE PROGRAMS	
JBD	THE ASIAN WALL STREET JOURNAL	***
JES	THE DESERT SUN	
JEG	THE FUTURE OF INFORMATION PROCESSING TECHNOLOGY	
JAY	THE JAPAN ECONOMIC JOURNAL	***
JEF	THE SUPERCOMPUTOR	
JCF	THIN SOLID FILMS	

APPENDIX 4 - LIST OF DATA SOURCE CODES - B: (ALPHABETICAL ORDER)

Page No. 8
05/03/90

TECHNOLOGY SOURCES
*** - INFORMATION OBTAINED FROM TRW SOURCES
THAT IS NOT READILY AVAILBLE
FROM OPEN SOUCRCES

SOURCE CODE	PUBLICATION NAME	UNIQUE TRW SOURCE
JFF	TRANSACTIONS OF THE JAPAN SOCIETY FOR AERONAUTICAL & SPACE SCIENCES	***
JFE	TRW E & T SYMPOSIUM - RECENT QUANTUM ELECTRONICS DEVELOPMENT IN JAPAN	***
JEE	TRW HIGH SPEED DATA PROCESSING EXPERT - SHI-PING-HSU	***
JEX	TRW INTERVIEW - FRANK COULTER REGARDING TECHNOLOGY A	***
JFD	TRW STUDY ON MASS STOREAGE DEVICES - JIM SOWDER	***

APPENDIX 5 - LIST OF CRITICAL TECHNOLOGIES AND SUB-TECHNOLOGIES

A. VOICE & DATA COMMUNICATIONS ENCRYTION (VDCE)

0901010A04 - VDCE - SYSTEM PERFORMANCE

B. SPACE BASED LASER COMMUNICATIONS (SBLC)

0901020200 - SBLC - SYSTEM PERFORMANCE

0601010100 - Nd: YAG LASER

0601010400 - HIGH-POWER SEMICONDUCTOR DIODE LASER

0702040201 - SEMICONDUCTOR SILICON AVALANCHE PHOTODIODE

0702040202 - GaAs P-I-N PHOTODIODES

0702040203 - PHOTOMULTIPLIER TUBE (PMT)

13040A0100 - BEAM COMBINER FOR GaAs LASER DIODE

13040A0200 - TELESCOPE OPTICAL SYSTEM

C. SYNTHETIC APERTURE RADAR FOR SPACE-BASED REMOTE SENSING (SARSBRS)

1407010A08 - SARSBRS - SYSTEM PERFORMANCE

PHASED ARRAY ANTENNAS, CORPORATE FEED:

1407030A08 - ACTIVE ARRAY DESIGN

1407030A09 - PASSIVE ARRAY DESIGN

PHASED ARRAY ANTENNA, LENS FEED:

1407030A10 - ACTIVE ARRAY DESIGN

1407030A11 - PASSIVE ARRAY DESIGN

1407030A12 - REFLECTOR ANTENNA, MECHANICAL SCAN

1407050A00 - REAL-TIME SIGNAL PROCESSOR

APPENDIX 5 - LIST OF CRITICAL TECHNOLOGIES AND SUB-TECHNOLOGIES

D. ATTITUDE CONTROL SYSTEMS FOR HEAVY SPACECRAFT (ACSHS)

1206010A01 - ACSHS - SYSTEM PERFORMANCE

1002030A01 - GYROSCOPE - FLOATED

1002040A01 - GYROSCOPE - DRY TUNED

1002050A01 - GYROSCOPE - RING LASER (RLG)

1002070A01 - GYROSCOPE - FIBER OPTIC (FOG)

1206040A01 - THRUSTER - GAS

1206050B01 - STAR SENSOR - CHARGE COUPLED DEVICE

1206050B02 - STAR SENSOR - IMAGE DISSECTOR

1206050B03 - EARTH SENSOR

1206050B04 - SUN SENSOR - ANALOG

1206050B05 - SUN SENSOR - DIGITAL

1206060A01 - CONTROL MOMENT GYRO - SINGLE GIMBAL

1206060A02 - CONTROL MOMENT GYRO - DOUBLE GIMBAL

1206060A03 - REACTION WHEEL

APPENDIX 5 - LIST OF CRITICAL TECHNOLOGIES AND SUB-TECHNOLOGIES

E. IR DETECTORS & FOCAL PLANE ARRAYS (IRDFPA)

1401000000 - IRDFPA - SYSTEM PERFORMANCE

FOCAL PLANE ARRAYS:

- 1401010A02 - ULTRA-VIOLET REGION (UV) CCD
- 1401020A02 - VISIBLE REGION - CCD

IR DETECTORS - PHOTOCONDUCTOR:

- 1401030A02 - SHEET A - Pbs
- 1401030A02 - SHEET B - InSb
- 1401030A02 - SHEET C - HgCdTe
- 1401030A02 - SHEET D - GaAs
- 1401030A02 - SHEET E - DOPED SILICON

IR DETECTORS - LINEAR ARRAY:

- 1401030A02 - SHEET F - PHOTODIODE
- 1401030A02 - SHEET G - CHARGED COUPLED DEVICE

IR DETECTORS - FOCAL PLANE ARRAY:

- 1401030A02 - SHEET H - HYBRID
- 1401030A02 - SHEET I - CCD

1401030A02 - SHEET J - IR DETECTOR - VIDICON

F. X-RAY LITHOGRAPHY (XRL)

0701050A02 - XRL - SYSTEM PERFORMANCE

0701050B02 - X-RAY RADIATION SOURCES

0701050C02 - SHEET A - X-RAY MASKS

0701050C02 - SHEET B - X-RAY RESISTS

APPENDIX 5 - LIST OF CRITICAL TECHNOLOGIES AND SUB-TECHNOLOGIES

G. E-BEAM LITHOGRAPHY (EBL)

0701050A01 - EBL - SYSTEM PERFORMANCE

0701050C01 - E-BEAM RESISTS

H. DIAMOND COATINGS AND FILM (DCF)

0704010A00 - DCF - SYSTEM PERFORMANCE

0704010B07 - DCF - PROCESS - WAFER

0704010B08 - DCF - PROCESS - SPOT

0704010B09 - DCF - PROCESS - LARGE SURFACES

I. HIGH SPEED DATA PROCESSING (HSDP)

0102000000 - HSDP - SYSTEM PERFORMANCE

0201010A00 - SUPERCOMPUTERS

0204010A03 - MAGNETIC DISK MEMORY UNITS

0204010A04 - HIGH DENSITY MAGNETIC TAPE MEMORY UNITS

0204020A03 - WRITABLE OPTICAL DATA STORAGE DISK UNITS

J. HIGH-RESOLUTION FLAT PANEL DISPLAYS (HRFPD)

0205010A00 - HRFPD - SYSTEM PERFORMANCE

0205010A01 - GAS DISCHARGE (PLASMA) DISPLAY PANELS

0205010A02 - ELECTROLUMINESCENT PANEL DISPLAYS

0205010A04 - LIQUID CRYSTAL DISPLAYS

0205010A07 - VACUUM FLUORESCENT DISPLAY PANELS

APPENDIX 6 - LIST OF KEYWORDS USED FOR DATA SEARCHES

A. VOICE & DATA COMMUNICATIONS ENCRYPTION

* AUTO-KEY CIPHERS
* CIPHERTEXT
* COMPUTATIONALLY SECURE CIPHER
* COMSEC
* CRYPTO
* CRYPTOANALYSIS
* DATA ENCRYPTION STANDARD (DES)
* DECRYPTION
* ENCODING
* ENCIPHERING
* ENCRYPTION
* FREQUENCY INVERTER
* HAGELIN MACHINE
* KEY
* KNOWN-PLAIN-TEXT-ATTACK
* ONE TIME TAPE
* PLAINTEXT
* POLYALPHABETIC CIPHER
* PUBLIC KEY
* ROTOR MACHINES
* RUNNING KEY CIPHER
* SCRAMBLERS
* SECURE COMMUNICATIONS
* SHIFT REGISTERS
* UNCONDITIONALLY SECURE CIPHER
* VOICE ENCRYPTION

APPENDIX 6 - LIST OF KEYWORDS USED FOR DATA SEARCHES

B. SPACE BASED LASER COMMUNICATIONS

* ACQUISITION TIME AND PROBABILITY
* ANGULAR POINTING ERROR
* BEAM COMBINER
* BIT ERROR RATE
* COHERENT DETECTION
* DIFFRACTION LIMITED BEAMWIDTH
* DIRECT DETECTION - PHOTON COUNTING
* FREE SPACE LASER COMMUNICATION
* GaAs P-I-N PHOTODIODES
* HETERODYNE CONVERSION GAIN
* HOMODYNE DETECTION
* IR TELESCOPE
* LASER COMMUNICATION
* LASER POWER
* NARROW LINEWIDTH
* Nd: YAG LASERS
* NONCOHERENT FREQUENCY SHIFT KEYING
* PHASE SHIFT KEY
* PHOTOMULTIPLIER TUBE (PMT)
* POINTING LOSS
* RECEIVER SENSITIVITY
* SEMICONDUCTOR GaAs PIN DETECTOR
* SEMICONDUCTOR LASER DIODE
* SEMICONDUCTOR SILICON PIN DETECTOR
* SHOT NOISE LIMIT
* SILICON AVALANCHE PHOTODIODE (APD)
* SINGLE LONGITUDINAL MODE
* TELESCOPE OPTICAL SYSTEM

(EXCLUDE "FIBER OPTIC" IN ANY SEARCH)

APPENDIX 6 - LIST OF KEYWORDS USED FOR DATA SEARCHES

C. SYNTHETIC APERTURE RADAR FOR SPACE BASED REMOTE SENSING

* ACTIVE ARRAY
* AREA SEARCH RATE
* AZIMUTH RESOLUTION
* CORPORATE FEED
* DIGITAL SIGNAL PROCESSOR
* DOPPLER
* LENS FEED
* MECHANICAL SCAN
* OPTICAL SIGNAL PROCESSOR
* PHASE SHIFTER
* PHASED ARRAY ANTENNA
* PULSE COMPRESSION
* RANGE RESOLUTION
* REAL-TIME SIGNAL PROCESSOR
* SIDE LOOKING RADAR
* SIGNAL PROCESSING
* SPACE-FED PHASED ARRAY
* SPOTLIGHT MODE
* STRIP MODE
* SYNTHETIC APERTURE RADAR (SAR)
* SWATH WIDTH
* TRANSMIT-RECEIVE (TR) MODULES

D. ATTITUDE CONTROL SYSTEMS FOR HEAVY SPACECRAFT

* ATTITUDE MANEUVERING
* AUTONOMOUS NAVIGATION
* CONTROL MOMENT GYRO
* DRY TUNED GYRO
* EARTH SENSOR
* FIBER OPTIC GYRO
* FLOATED GYRO
* GAS THRUSTER
* GIMBAL
* NOMINAL ATTITUDE
* ORBIT ADJUSTMENT
* POINTING ACCURACY
* POINTING KNOWLEDGE
* REACTION WHEEL
* RING LASER GYRO
* SHAPE CONTROL
* STAR SENSOR -CCD
* STAR TRACKER-IMAGE DISSECTOR
* SUN SENSOR
* THRUSTER
* VIBRATION CONTROL

APPENDIX 6 - LIST OF KEYWORDS USED FOR DATA SEARCHES

E. IR DETECTORS & FOCAL PLANE ARRAYS

* BACKGROUND LIMITED PERFROMANCE (BLIP)
* BACKPLANE SIGNAL PROCESSING
* BLOCKED IMPURITY CONDUCTION
* BRAYTON-CYCLE COOLER
* BURIED CHANNEL DEVICES
* BUTTABLE ARRAYS
* CHARGE COUPLED DEVICE (CCD)
* CLOSED-CYCLE COOLER
* CRYOGENIC COOLERS
* DETECTORS (PbS, InSb, HgCdTe, GaAs, DOPED Si)
* DEWAR COOLER
* EXTRINSIC SILICON
* FOCAL PLANE ARRAY
* FORWARD LOOKING INFRARED (FLIR) DETECTOR
* GALLIUM ARSENIDE
* HETERODYNE
* HYBRID ARRAYS
* INDIUM ANTIMONIDE
* INTRINSIC IR CCD
* IR DETECTOR
* JOULE-THOMSON COOLER
* LINEAR ARRAY
* LEAD SULFIDE
* LEAD ZINC TELLURIDE SUBSTRATE
* LONG WAVE INFRARED (LWIR) DETECTOR
* MEDIUM WAVE INFRARED (MWIR) DETECTOR
* MERCURY CADMIUM TELLURIDE
* MICROCHANNEL PLATES
* MONOLITHIC IR CCD
* OPEN-CYCLE COOLER
* PASSIVE RADIATOR COOLER
* PELTIER EFFECT COOLER
* PHOTOCONDUCTOR
* PHOTODIODES
* PLATINUM SILICIDES
* QUAD CELL
* ROTATING RECIPROCAL REFRIGERATOR
* SAPHIRE SUBSTRATE
* SCHOTKY BARRIER ARRAYS
* SHORT WAVE INFRARED (SWIR) DETECTOR
* STIRLING COOLER
* THERMOELECTRIC COOLER
* ULTRAVOILET DETECTOR
* VIDECON
* VISIBLE REGION DETECTOR
* VUILLEUMIER COOLER
* Z-PLANE TECHNOLOGY
* Z-TYPE HYBRID

APPENDIX 6 - LIST OF KEYWORDS USED FOR DATA SEARCHES

F. X-RAY LITHOGRAPHY

* BESSY
* BORON NITRIDE
* COSY
* LASER PLASMA
* LITHOGRAPHY
* PLASMA SOURCE
* RADIATION SOURCE
* RETICLES
* SILICON CARBIDE
* SILICON NITRIDE
* STEP-AND-REPEAT
* SUBMICRON LITHOGRAPHY
* SYNCHROTRON
* WAFER STEPPERS
* X-RAY MASKS
* X-RAY RESIST
* X-RAY TUBES
* .05 MICRON STRUCTURE

G. E-BEAM LITHOGRAPHY

* DIRECT WRITE
* EBL
* E-BEAM RESIST
* ELECTRON BEAM
* MASK PRODUCTION
* POSITIVE RESIST
* SUBMICRON LITHOGRAPHY
* VECTOR SCAN

H. DIAMOND COATINGS AND FILMS

* CHEMICAL VAPOR DEPOSITION
* DEPOSITION RATE
* DIAMOND COATINGS
* DIAMOND FILMS
* DIAMOND LIKE CARBONS
* ELECTRON ASSISTED CHEMICAL VAPOR DEPOSITION
* GROWTH RATE
* HEATED FILAMENT PROCESS
* HYDROGEN/METHANE FEEDSTOCK
* PLASMA ASSISTED CHEMICAL VAPOR DEPOSITION
* RAMAN SPECTRUM
* SAPPHIRE SUBSTRATE
* SILICON SUBSTRATE

APPENDIX 6 - LIST OF KEYWORDS USED FOR DATA SEARCHES

I. HIGH SPEED DATA PROCESSING

* DATA TRANSFER RATE
* HELICAL SCAN RECORDING
* HIGH BANDWIDTH
* HIGH DENSITY DATA RECORDER
* IMMERSION COOLING
* JUKEBOX
* MAGNETIC DISK MEMORY
* MAGNETIC TAPE MEMORY
* MASS STORAGE
* MULTIPLE PROCESSORS
* PARALLEL TRANSFER DISKS
* READ/WRITE HEADS
* STORAGE CAPACITY
* SUPERCOMPUTERS
* THIN FILM MEDIA
* VECTOR PROCESSING
* VERTICAL RECORDING
* VIDEO DISKS
* WRITEABLE OPTICAL DISKS

J. HIGH-RESOLUTION FLAT PANEL DISPLAYS

* CAPACITIVE TOUCHSCREEN
* CONTRAST RATIO
* ELECTROLUMINESCENT DISPLAY (ELD)
* GAS DISCHARGE DISPLAY
* HIGH DEFINITION TELEVISION (HDTV)
* LIQUID CRYSTAL DISPLAY (LCD)
* PIXELS
* PLASMA DISPLAY PANELS (PDP)
* RESISTIVE MEMBRANES
* SCANNING IR
* SURFACE ACOUSTIC WAVE TOUCHSCREEN (SAW)
* TOUCHSCREENS
* TWISTED-NEUMATIC LCD
* VACUUM FLUORESCENT DISPLAY (VFD)
* VIEWING ANGLE